Interaction Between Groundwater and Surface Water Regimes and Mining-Induced Acid Mine Drainage in the Stockett-Sand Coulee Coal Field

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TECHNICAL COMPLETION REPORT

Interaction Between Groundwater and Surface Water Regimes and Mining-Induced Acid Mine Drainage in the Stockett-Sand Coulee Coal Field

Project A-129MONT

to

Montana Joint Water Resources Research Center
Montana State University
Bozeman, Montana 59715

and

Montana Department of State Lands Helena, Montana

bу

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ABSTRACT

Abandoned underground coal mines in the Stockett and Sand Coulee, Montana region have been discharging acid water for many years, causing severe pollution of Sand Coulee Creek and tributaries, and ground-water resources. A two-year investigation of the hydrogeology of the Sand Coulee Creek basin was conducted to formulate acid mine drainage mitigation techniques base on hydrologic systems controls and de-centralized neutralization.

Periodic field inventories in 1980-83 located at least 17 acid discharge points flowing either perennially or ephemerally. The measured total rate of acid discharge ranged from 1-3.3 ft³/s. Most acid discharges were of very poor quality with field pH ranging from 2.2 to 5.4, acidity from 108 to 6002 mg/l as CaCo₃ and specific conductance from 1038 to 15,966 microsiemens per centimeter. Water types were mostly ferrous-alluminum sulfate with dissolved iron concentrations from 12 to 1065 mg/l.

Two stream gaging stations were installed on Sand Coulee Creek and one on Straight Creek. Although the watershed area of Straight Creek is only 4% that of Sand Coulee Creek, it had longer duration and sometimes greater magnitude baseflow, primarily composed of acid mine drainage. Acid water comprises roughly 60-90 % of the baseflow of Sand Coulee Creek. Most baseflow is lost to evapotranspiration and subsurface seepage.

A regional inventory of 46 domestic wells indicated that approximately one-half utilized the Madison Limestone aquifer as the primary water source with most of the remainder equally divided between Kooten-

ai sandstone and Jurassic sandstone aquifers. Most alluvial ground water is polluted and has not been utilized by residents for many years. Vertical ground-water gradients are primarily downward which has allowed mine drainage contamination to reach the Jurassic and Madison aquifers. Water quality analyses and chemical modeling indicated the probable contamination of seven of sixteen sampled wells in these aquifers. Mine drainage water reaches lower bedrock aquifers through stream seepage, alluvial ground-water leakage and well bore leakage.

Proposed mitigation techniques included, infiltration control through cultivation of water consumptive crops and grain re-cropping in recharge areas, vertical connector wells or horizontal wells to dewater the Kootenai aquifer overlying the old coal mines, injection and neutralization of acid water in the Madison limestone and small-scale neutralization pits using flyash and alkaline Kootenai ground water.

Key words: Acid mine drainage, streamflow seepage, surface waterground-water interaction, ground-water contamination, infiltration control, drainage wells.

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1. INTRODUCTION

This report presents results of the Montana Water Resources

Research Center project no. A-129MONT, Interaction between ground water
and surface water regimes and mining-induced acid mine drainage (AMD)
in the Stockett-Sand Coulee Coal Field. The second year of the project
was 50% funded by the Montana Department of State Lands, Helena, Montana. The project was conducted by the Montana Bureau of Mines and
Geology, Butte, Montana in 1981-83.

1.1 Problem Description

Coal in the Stockett-Sand Coulee area, near Great Falls, Montana, occurs within the upper part of the Morrison Formation (Jurassic) and is exposed along outcrops in the valley of Sand Coulee Creek and its tributaries. Unlike the Eastern Montana Tertiary coal deposits, the coal in this area is higher in grade (bituminous) as well as in sulfur content (0.5-5.5%) and is moderately high in ash (about 20%) (Silverman and Harris, 1967). Mining in the area commenced before the turn of the century via numerous adits which were constructed along the bottoms and sides of the major coulees. The last large-scale mine closed in 1952, but some recent exploratory drilling has been concentrated in the area between Great Falls and Stanford, where these coal deposits occur generally within 100-300 feet of land surface.

The extensive underground mining activity has allowed easy access for oxygen and water to enter the system of abandoned mines, and as a result, the area now has an extensive acid mine drainage problem.

Ground water infiltrates through the overlying Kootensi Formation into the Morrison Formation, oxidizing pyrite within the abandoned mines and

discharging at low pH (2.3-5.0) from abandoned mine portals or through mine spoil backfill materials.

While the existing problem is primarily the result of mining activities, it is possibly being enhanced by non-water conservative summer-fallow cropping practices on the upland benches, which increase the amount of water that moves into the subsoil and then into the Kootenai Formation. Any future mining operations which become active in this area will have to confront the hydrologic impacts of their activities during and after mining. In light of the proposed construction of coal-fired generating facilities in the Great Falls area within 20 miles of this old mining district, the probability of new mines being established somewhere in the Great Falls-Lewistown coalfield, although remote, is as great as it has been in the last 30 years. A location map is shown in Figure 1.

1.2 Previous Work

Fisher (1909) published the first report on this area, describing the geology and coal resources in some detail and including a brief description of the mining operations active at that time. A chemical analysis of spring water near Stockett was made, which indicated that the water was alkaline and unpolluted.

Goers (1964) performed a geological study of the Stockett-Smith River area, which included field inventory of a number of water wells in this area.

Silverman and Harris (1967) deacribed the geology and stratigraphy of the Great Falls-Lewistown Cretaceous coal field. A generalized stratigraphy and detailed isopachs of coal sequence were presented.

Also, geochemical characterization of a limited number of coal samples was performed.

McArthur (1970) performed a detailed short-term study of the environmental aspects of acid mine drainage in the Stockett-Sand Coulee area. He performed a detailed spring inventory and measured flows and pH over an eight month period for selected springs and surface-water stations. His work included an assessment of the hydrologic system, some water quality analyses and presentation of some alternatives for mine water neutralization, including limestone or lime treatment and mine flooding.

Hydrometrics (1982) submitted an extensive and comprehensive report on abandoned mine lands in the Belt-Sand Coulee area, concentrating on, but not limited to, the hydrology of acid mine water in this area. They provided a complete literature review, an assessment of amelioration alternatives and a re-inventory of the springs in this area. Some hydrologic data was collected, although only over a four month period.

1.3 Study Rationale

This project was designed to collect sufficient data to allow assessment of alternatives to centralized treatment of acid mine drainage. An ideal alternative to treatment would dispose of and/or prevent acid mine discharge in an inexpensive manner, easily applied over an extensive area, with reasonable maintenance. This investigation focused on the hydrogeologic background of two general amelioration techniques which may meet these criteria:

- Infiltration control; whereby the amount of water infiltrating the old mine workings is reduced by minimizing ground-water recharge or dewatering the overlying aquifer; and
- 2) On-site neutralization methods involving surface neutralization of the numerous small acid seeps in small ponds or by gravity injection and neutralization of acid water within the underlying limestone of the Madison group rocks.

1.4 Project Objectives

Project objectives for the first year of study (FY 81) were as follows:

- Initiation of a comprehensive inventory of all springs and water wells in the study area, including a re-inventory of springs recorded by McArthur (1970);
- 2) Establishment of 1-3 permanent stream gaging stations in the Sand Coulee drainage, including Straight (No-Name) Creek;
- 3) Initial monitoring of springs in the area for flow, pH and specific conductance;
- 4) Water quality analysis, to characterize ground- and surfacewater quality and to support investigation of their interaction.

Project objectives in the second year included:

- 1) Continuation of acid discharge monitoring;
- 2) Streamflow monitoring via the gaging stations and seepage runs;
- Completion of a comprehensive domestic well inventory, aquifer identification, static water levels and field water quality characteristics;

- 4) Collection and analyses of ground-water quality data;
- 5) Preparation of a proposal for implementation of AMD mitigation techniques using hydrologic systems controls.

1.5 Study Site Reference System

All springs and streamflow stations were numbered using an arbitrary sequential reference system, organized by drainage basin.

Acid discharge reference codes used in this and previous investigations are shown in Table 1.

Straight Creek, as it is called by local residents, is not named as such on the U.S. Geological Survey (USGS) quadrangle map, but refers to the drainage through the town of Sand Coulee that is tributary to Sand Coulee Creek. This drainage is referred to by McArthur (1970) as "No-Name Creek".

Hereafter, the term "study area" is used to refer to the drainage area of Sand Coulee Creek from its headwaters to a point about two miles north of Tracy, Montana, where the creek enters the abandoned Missouri River channel. The principal towns of the study area are from north to south, Tracy, Sand Coulee, Centerville and Stockett, shown in Figure 1.

2. RESULTS

2.1 Springs

2.1.1 Spring Inventory and Monitoring

During the first year of the project, 17 springs were found to be discharging acid water from mine portals or spoil piles either perennially or intermittently (Figure 2). Nine springs flowed perennially,

while eight flowed only during or after spring precipitation and snowmelt periods. These springs in general corresponded to those observed by McArthur (1970) to be active in 1969. Five springs which flowed in 1969 (McArthur's 36-3, 36-6, 7-8, 7-9 and 18-5) were not observed to flow in 1980-81. Another seep in a spoil pile (13-2) found by McArthur has apparently become plugged in recent years. A large seep area near the old Giffen mine was not included in MacArthur's inventory, possibly because the pH is not below 4 at all times of the year.

Table 2 describes the active springs; ranges of flow, conductance and pH.

These springs were monitored on a periodic basis, to evaluate annual variability in flow and water quality. The results are included in Appendix A. During the period from 6-1-80 through December 1981, results for the monitoring may not be representative of the average year. The winters of both 1979-80 and 1980-81 were very dry in the study area, despite ensuing wet spring seasons. However, the patterns of variability and response of the acid springs to precipitation events are probably typical. The net discharges of acid mine water for this two-year period may be slightly below the long-term average.

Based on the monitoring to date, the acid springs can, with several exceptions, be separated into two arbitrary groups. The first group consists of springs with high flow variability (those which have a ratio of high flow to low flow greater than 5 and very rapid response to major springtime precipitation or snowmelt events, usually responding within a few days). These springs are usually associated with mine adits located less than 150 vertical feet below the top of the overlying bench. The second group also exhibits springtime increases in

flow but to a much lesser degree. These adits are located a greater vertical distance from the adjacent uplands where the ground-water flow system is recharged.

Springs in the first group (variable discharge) are in all cases located north of the town of Stockett, including the springs near the towns of Sand Coulee and Centerville. Some of these springs with exceptionally high variability include AS-01 (from 43-500 gallons per minute (gpm)), AS-07 (from 12.5-250 gpm) and CS-10 (from 0-80 gpm). In May 1981, peak flows at springs were obtained within two weeks of the end of the period of most intense precipitation. The pH in springs of the first group ranges from 2.29-4.20, with most in the range 2.3-2.9. Most springs (AS-03, AS-02, AS-04, AS-01, AS-07) tend to become only slightly more alkaline during high flow periods in the spring, probably due to dilution by alkaline recharge. Others (AS-06, CS-10) become more acid, probably due to flushing of pockets of stagnant water of high acidity from the mines due to an increased flow caused by infiltration on the upland benches. Recharge water infiltrating into the mines must not be of sufficiently high alkalinity or volume to reduce the acidity of the discharge.

Figure 3 shows spring discharge measured on 5/28/81, immediately after intense spring rains. The flows are, in all cases, the highest observed for each acid spring during 1980-1981 and in some cases represented an order of magnitude increase over discharge at low flow. Actively discharging acid springs are common along the west side of the upland bench separating Straight Creek from Sand Coulee Creek and are east of this bench relatively scarce in the Centerville area. This suggests that the springs in the town of Sand Coulee are locally re-

charged and that ground water flows in these mines to the northwest, possibly conforming to the dip of the Morrison and Kootenai beds beneath this bench. The total measured acid discharge from all springs was a minimum of about 358 gpm $(0.8 \text{ ft}^3/\text{s})$ on 3-5-81 and a maximum of about 1479 gpm $(3.3 \text{ ft}^3/\text{s})$ on 5-28-81.

Specific conductance (S.C.) values of mine discharge (Figure 4), taken at the same date, are in most cases not greatly lower than at other times of the year and in several springs is actually higher than at low flow. S.C. ranges from 476-10,306 microsiemens per centimeter (us/cm), with the springs discharging water of less than 1000 us/cm being either alkaline or dominated by alkaline recharge. Most spring discharges are in the range from 2000-7000 us/cm. Dissolved ferrous iron concentrations and concentrations of suspended ferric hydroxide have a large influence on the S.C. of these waters, and for this reason S.C. is probably less indicative of other water quality characteristics than it is for most natural waters. Spatial patterns are not apparent in this S.C. data, but generally springs which emit from backfilled minespoil materials are of poorer water quality and higher conductance than those discharging from open adits.

Specific conductance variations indicate that, despite the large increases in flow in the spring, very little dilution by recharge water is taking place. Most conductance values decreased by less than 25% in May 1981, in response to over 6 inches (in.) of local precipitation. Several springs (AS-06, AS-07) actually increased in conductance, suggesting again that isolated pockets of poor quality water in the mines are being flushed in the spring and lie stagnant during much of the rest of the year.

The very rapid hydrologic response of most acid springs suggests substantial interconnection between the surface and the mine workings, probably along vertical joints and fractures sometimes visible along valley walls. The morphology of stream and coulee orientations in the region suggests structural control which may be another expression of this joint system.

Several open adits were found in the bottom of Mining Coulee, south of Sand Coulee, where high water marks indicated that large volumes of surface runoff pour directly into the old mine workings. The rapid response of AS-Ol, in particular, may be related to this apparent surface water infusion.

From well records, saturated sandstone strata occur throughout the Kootenai Formation although only the basal sandstone unit shows extensive continuity and saturation. Recharge along fractures may increase the pressure head within these beds and augment the rate of leakage from these perched aquifers through fractures into the underlying basal Kootenai. The conglomeratic sandstone unit at the base of the Kootenai probably forms the roof of many of the mine adits and is the primary source of ground-water leakage into the old workings.

Increase of seepage rates from the basal Kootenai into the mines increases ponding of water within the mines and flushes pools of acid mineralized water towards the portals. Due to the slope of the adits, they drain freely and oxygen has ready access, allowing pyrite oxidation to occur at a high rate.

The recharge-discharge relationship for most acid springs is believed to be quite local. For example if the mean annual flow rate from ASO1, ASO2, ASO3 and ASO7 is estimated to equal 300 gpm (0.668

cubic feet per second (ft^3/s)), assuming the approximately 3 square miles (mi^2) bench area south of Sand Coulee to be the recharge area, the annual recharge rate would equal 3 in. This represents about 19% of the mean annual precipitation, a reasonable estimate for this area.

Only a few springs fall into the second, low-variability category. They include CS-09, along Cottonwood Coulee two miles south of Stockett, and BS-01, the Giffen Mine East outflow. Both occur at elevations nearly 200 feet below the surrounding upland benches where ground water is recharged. This additional separation from recharge apparently dampens the spring response to rainfall and snowmelt infiltration. The Giffen Spring increased in flow by a factor of about 1.5 in May 1981; its water quality decreased considerably, with pH decreasing more than a whole unit and conductance increasing from 6000 to 8600. During fall and winter, at low flow, both pH and water quality improve somewhat.

The Giffen Spring (BS-01) produces relatively consistent baseflow, averaging 250 gpm (3040 acre-feet/year) during the 1981 water year. Local precipitation was probably slightly higher than the local average of 15 in./year, although no accurate precipitation data are available from this specific locality. Assuming 16 in. total for the year and assuming, quite liberally, that 50% (8 in.) of this precipitation contributed to ground water as infiltration rather than contributing to crop use, runoff, or evapotranspiration, then discharge from these mine workings was recharged from an area at least as big as 7.12 mi.², an area greater than the 3-4 mi.² available for recharge along the upland bench immediately to the east of the mine. It is probable that groundwater flow in the Kootenai moving down gradient from its recharge area towards the Belt Mountain foothills is being intercepted by the old

mine workings and discharging from the north-westerly sloping Giffin adit.

2.1.2 Spring Water Quality

Water quality data collected from springs in 1980 and 1981 are listed in Appendix A (A-2). Field pH for spring waters ranges from 2.38-3.98 for all sites except BS-01, the Giffen mine, where it ranges from 3.8-5.4. While none of these springs are alkaline, acidity shows a broad range, from 108 (BS-01) to 6002 (AS-03) milligrams per liter (mg/L) as CaCO₃. The waters are ferrous-aluminum-sulfate dominant, with minor calcium and magnesium. Iron (Fe) (12-1065 mg/L) and aluminum (Al) (1.72-752 mg/L) are the most abundant metals, although there are also high concentrations of trace metals including nickel (Ni) (0.24-5.31 mg/L) and zinc (Zn) (0.60-21.5 mg/L). Lesser (<1 mg/L) but detectable concentrations of cadmium (Cd), chromium (Cr), copper (Cu), and in some cases molybdenum (Mo) also occur. Both arsenic (As) (<80 parts per billion (ppb)) and selenium (Se) (<21 ppb) are at low concentrations.

Ferrous iron is dominant over ferric at the mine mouths, although some minor amounts of iron in excess or dissolved iron were recovered-probably ferric hydroxides in suspension in the water. FeSO $_4^{\circ}$, AlSO $_4^{+}$, and Al(SO $_4$) $_2^{-}$ are all strong complexes in this solution. Sulfate activities are probably at a plateau in some of these waters, due to the fact that the majority of any sulfate added to the water is probably complexed by either iron, aluminum, or alkaline earths and many waters are saturated with respect to gypsum. As the iron oxidizes and drops out of solution downstream, the sulfate activities might be

expected to increase and possibly cause other sulfate species to attain saturation.

These waters are undersaturated with respect to all but a few mineral phases. One is gypsum; another is chalcedony, which becomes supersaturated in neutralized waters due to dissolution of silicates under acid conditions.

2.2 Ground Water

Ground water occurs in most all of the permeable rock units in the Stockett-Sand Coulee area. A description of the geologic formations in the area is given in Appendix B. From oldest to youngest age, aquifers are known to yield water to wells from the Mission Canyon formation of the Madison Group (Mississippian), the Swift Sandstone (Jurassic), sandstone beds in the lower Kootenai formation (Lower Cretaceous), glacio-fluvial and glacio-lacustrine deposits (Quaternary) and stream alluvium (Quaternary). Figure 5 is a schematic hydrogeologic section. Vertically stacked aquifers separated by shale aquitards frequently occur, and surface water-ground water interaction is a common phenomenon. Ground water movement is primarily horizontal within specific aquifers, in response to the hydraulic gradient. Vertical movement of ground water can occur when two aquifers are in direct contact with each other, when natural rock fractures or man-made features such as well bores allow vertical movement, or by slow leakage through aquitards.

An inventory of domestic water wells in the study area was completed in summer 1982. Field data are presented in Appendix C (C-1) and included owner, location, static water level, field specific conductance and pH and water use information. Measured static water levels, and S.C.'s are shown in Table 4 and are referenced to a location map in Figure 6. Field data were correlated with the Montana Ground Water Appropriation forms which gave useful information on well completion, yield and the lithology encountered in drilling. A total of 46 domestic wells were inventoried on at least one occasion. The Madison limestone aquifer supplied 24 wells, Jurassic sandstones 11, Kootenai sandstones 10, and alluvium only 2. Five wells were completed in multiple aquifers and the water bearing source of two wells could not be estimated at all.

2.2.1 Madison Aquifer

The Mission Canyon Formation of Mississippian Age is the principal aquifer in the Madison Group Rocks. It is composed of massive light-gray limestone and thin dolomite interbeds which have been extensively karstified. Ground water flows through fractures and solution cavities that may occur from near ground surface to depths of at least 700 feet. The aquifer appears unconfined to moderately confined in the study area based on water level data, and some Madison wells in the Centerville and Tracy area expel and suck air with considerable force. Horizontal ground-water flow is generally from south to north (Feltis, 1980, 2). Vertical ground-water flow in the study area is downward with some deeper Madison wells having lower static water levels than shallower ones.

The primary recharge area for the Madison aquifer is on the flanks of the Little Belt Mountains where many square miles of Madison Group rocks are exposed to relatively high precipitation (20 in. or more

annually). Additionally, streams are reported to lose water as they traverse portions of the Madison outcrop. More limited recharge occurs in the study area where local doming of the Madison results in exposures of fractured limestone in the Centerville-Stockett area. Streamflow from Number Five Coulee and Cottonwood Coulee directly infiltrates Madison rocks. The Madison also probably receives recharge as leakage from overlying saturated alluvium. Results of water quality analyses indicates that some of this recharge is acid mine drainage water.

The best known discharge point for the Madison aquifer is Giant Springs just east of the city of Great Falls. Approximately 300 ft³/s of ground water issues from large springs near and in the Missouri River (Patton, 1983). Between Tracy and Great Falls, the Madison aquifer may develop upward vertical leakage and discharge to overlying aquifers and to the pre-glacial Missouri River Channel south of Great Falls. Water quality and head data from the Madison, Swift and Kootenai aquifers is often similar, suggesting a high degree of interaquifer connectivity just north of the study area.

2.2.2 Swift Aguifer

The Madison Group is unconformably overlain by Jurassic marine sediments of the Ellis Group. Sandstone of the Swift Formation directly overlays the Mission Canyon Formation in much of the study area. The Swift is a fine- to medium-grained, well-cemented quartz sandstone from 0-40 feet thick. It appears cross-bedded or massive in outcrop, weathering to a pale orange to brown color. Beds of chertpebble and brachiopod shell hash conglomerate may occur in the lower part. The Swift occurs over most of the study area and is well exposed

in the coulee bottoms of Cottonwood Creek north of Stockett and Number Five Coulee southwest of Stockett.

The Swift sandstone is known to yield water to three wells in the Tracy vicinity south of Stockett, and it is the probable source of two springs issuing near the bottom of Cottonwood Creek below the Morrison coal seam. Relatively little is known concerning the extent, thickness and water-yielding characteristics of the Swift sandstone between Stockett and Tracy. In the Sand Coulee Creek Valley north of Center-ville, water wells drilled to the Madison sometimes do not encounter the Swift sandstone, indicating it is probably removed by erosion. One Swift well just northwest of Tracy was sampled and has a TDS of 1,994 mg/l, indicating potential contamination from AMD in nearby Sand Coulee Creek. Data are too sparse to construct a potentiometric map of the Swift, although flow is believed to occur from south to north.

The recharge-discharge regime of the Swift aquifer is not well known. Like the Madison, it is probably recharged where exposed along the flanks of the Little Belt Mountains and to a lesser extent in the study area, where local doming and erosion in coulees bring the ground surface close to the elevation of the Swift Sandstone. Since there is no observable confining bed between the Swift and Madison aquifers, they may act as a unit north of Tracy where the Madison becomes fully saturated. Similar heads and water quality between Tracy and Great Falls further suggest the inter-connectivity of the Madison and Swift aquifers.

The Swift Formation is overlain by the Morrison Formation which consists of 100-200 feet of gray shale with interbedded sandstone, limestone and coal. The Morrison coal bed or beds occur near the top

of the Jurassic section and were the target of mining in the area.

2.2.3 Kootenai Aquifer

The Lower Cretaceous freshwater Kootenai Formation is present at land surface over most of the study area and unconformably overlays the Morrison Formation. The basal unit of the Kootenai is a resistant, cross-bedded, coarse, salt and pepper sandstone bed, from 2-80 feet thick (Walker, 1974). Above this basal sandstone, the Kootenai consists of numerous, lensaic, poorly continuous sandstone beds, 1-50 feet thick, interbedded with green, gray and maroon mudstone. The Kootenai is typically 100-300 feet thick in the study area with 100-300 feet of the upper Kootenai member having been removed by erosion. The basal conglomeratic sandstone unit directly overlays the Morrison coal bed and is a relatively continuous aquifer supplying wells throughout the study area. More discontinuous sandstone beds occur stratigraphically higher on the Kootenai and occasionally yield water to wells and springs.

Horizontal ground-water flow in the basal Kootenai aquifer is generally from the topographically high benchlands to nearby coulees bisecting the Kootenai formation. There is a regional bedrock dip of approximately 3-6 degrees to the north-northwest and ground water migrates down dip, commonly resulting in springs and seeps on the northwest terminus of benches. Southern and eastern Kootenai outcrops are usually drier. In unmined areas, natural springs are common at the contact of the basal Kootenai with the less permeable Morrison Formation.

The many thin sandstone and shale beds in the Kootenai are quite

brittle and flexure of the South Arch in Tertiary time resulted in extensive fracturing of the Kootenai rocks. These fractures and related joint systems readily allow vertical ground-water movement and recharge from surface sources. The limited data available from domestic wells indicates that the basal Kootenai aquifer is sometimes confined in the middle of benches, and is frequently unconfined in wells near the edge of benches where the Kootenai section is bisected.

In relation to acid mine drainage, the removal of the coal bed underlying the basal Kootenai sandstone aquifer has resulted in leakage of ground water into the old mine workings. The old tunnels and rooms are efficient ground-water drains, which locally dewater the basal Kootenai sandstone and allow water to be conveyed down-gradient to old mine portals situated at the outcrop areas in the principal coulees. The normally alkaline Kootenai ground water is exposed to atmospheric oxygen and pyrite in the old mines where the chemical oxidation process occurs, producing AMD.

2.2.4 Quaternary Aquifers

Ground water occurs in stream alluvium deposits of Sand Coulee Creek and tributaries in the study area. These deposits are relatively thin south of Sand Coulee and Centerville, typically 10 to 30 feet thick. North of these towns, the valleys of Sand Coulee Creek have been filled with a combination of alluvial, glacial, and lacustrine deposits to thicknesses of up to 150 feet as recorded by water well drillers. The alluvial deposits are typically sand and fine-medium size gravel, gravelly clay, sandy loam, and sandy clay, brown to yellow-brown in color.

Evidence of glacial and lacustrine deposits comes from the widespread influence of Pleistocene continental glaciation throughout the
Great Falls area as described by Alden (1932) and Walker (1974).
Several water well logs in the Tracy vicinity record alternating
deposits of yellow, sandy clay and gray silt, consistent with a
postulated sequence of glacial deposits and lacustrine deposits from
ice-marginal glacial lakes.

Water wells in the abandoned pre-glacial Missouri River Valley north of the study area are reported to obtain good yields of ground water from scattered sand and gravel lenses (Walker, 1974). But the lateral occurrence and depth of these deposits are unpredictable. Wilke (1983) inventoried at least 5 water wells completed in Quaternary deposits found in the pre-glacial channel.

Although most of the alluvial deposits in the study area are saturated, little use is currently made of alluvial ground water due to AMD contamination. Only south of Stockett, above the highest elevation AMD source, is significant use made of alluvial ground water. The town of Stockett obtains a portion of its water supply from an alluvial infiltration gallery about 2 miles south of town. However, local residents report high iron problems occur in the spring when ephemeral AMD sources discharge upgradient from the collector.

The alluvial deposits of Sand Coulee Creek and tributaries are the intermediate receptor of most visible AMD in the study area. Stream channels cut into the alluvium carry most of the AMD discharge. However, in the Sand Coulee and Centerville vicinity, as the alluvial deposits deepen, streamflow is partially or entirely lost to the alluvium. AMD is therefore a continued source of recharge to the alluvium.

North of Tracy, the alluvium is apparently in direct contact with the Madison limestone. Reports from drillers indicate that the vertical gradient is downward, thereby allowing AMD contaminated alluvial ground water to recharge the Madison aquifer. Local residents also report that the acid alluvial ground water has caused failures of cement grout and steel casing in the alluvium and that downward leaking alluvial ground water has contaminated formerly good quality Madison aquifer ground water.

2.2.3 Ground Water Quality

The chemical quality of ground water in the Stockett-Sand Coulee area is quite variable due to the different types of rocks comprising the multiple aquifers, the effects of AMD, the hydraulic connections between aquifers and surface water-ground water interactions.

In general, it is possible to discuss each aquifer as having its own "characteristic" water quality and intra-aquifer trends. Variations from the typical condition are most often due to inter-aquifer mixing or to chemical reactions imparted by acid mine drainage water. Water quality data from laboratory analyses of sampled wells are presented in Appendix C (C-2).

2.2.5.1 Madison Aquifer

Water wells tapping the Madison aquifer southeast of the Missouri River near Great Falls usually have total dissolved solids (TDS, calculated) concentrations usually in the range of 400-600 mg/l. Giant Springs, several miles northeast of Great Falls, is thought to be a regional discharge point for the Madison aquifer. The spring has been

mg/l and approximately equal milliequivalence of ${\rm Ca}^{2+}$, ${\rm Mg}^{2+}$, ${\rm HCO}_3$, and ${\rm SO}_4^{2-}$ (Patton, 1983). Feltis (1980, 1) mapped TDS concentrations of Madison wells throughout northern Montana which showed a concentration gradient of less than 1000 mg/l near mountain uplifts to over 10,000 mg/l in the Williston basin. The density of wells sampled, however, except in the Great Falls and oil field areas, is quite low.

The chemical quality of Madison wells sampled in the Sand Coulee area is quite variable and does not fit expected patterns. Figure 7 is a histogram indicating that seven of twelve Madison samples were less than 600 mg/l, and five ranged from 600 to 2,413 mg/l. The five high TDS samples had milliequivalent ratios of sulfate to bicarbonate of from 1.7 to 7.7. Figure 8 is a Piper plot which graphically illustrates the progression of increased sulfate concentrations among the samples. An analysis of Giants Springs is included for comparison.

Since the high TDS wells are scattered throughout the study area, there is little evidence to support a water quality trend of this magnitude based on length of ground-water flow path. Anhydrite beds known to occur in the Charles Formation which, in places, overlies the Mission Canyon Formation, could be a source of sulfate and TDS increases. However, the Charles Formation is not known to occur in this area and lithologic logs of water-well drillers have not indicated any evaporitic zones in the study area.

Although natural sources cannot entirely be ruled out, at this time a plausible explanation for the anamalously high TDS and sulfate concentrations is the infiltration and mixing of AMD water with native Madison aquifer ground water. Higher TDS and sulfate concentrations

are a byproduct of the acid producing metal oxidation reactions that take place in the old mines and during surface water or ground-water transport of AMD. It is believed that the contaminated Madison wells are generally down-gradient from an AMD source, particularly if the well is in a tributary coulee bottom. The downward gradient and possible fractures associated with the coulee may provide the conditions favorable for contamination. Figure C-3 (Appendix C) shows the proximity of AMD sources to the Madison aquifer wells in the study area. Chemical models of the AMD and Madison ground-water interaction are presented in section 3.3.

2.2.5.2 Jurassic Aquifers

The Swift Formation is the most prevalent Jurassic aquifer in the study area, however, other water-bearing sandstones occur regionally in the Morrison Formation which overlies the Swift sandstone. Four Jurassic aquifer samples were collected in this investigation but lack of well log information prevented differentiating the specific water-bearing zones.

Three of the Jurassic aquifer samples are calcium-magnesium-bicarbonate types with TDS of 277 to 433 mg/l, and one, the Lyman well, is a calcium-magnesium-sulfate type, with a TDS of 1737 mg/l. The analyses are plotted on a Piper diagram in Figure 9.

Wilke (1983) reported analyses from three Morrison wells and two Swift wells in the Great Falls vicinity. Morrison wells had TDS (sum of constituents) range of 908-1480 mg/l and had mixed water types. The Swift wells had TDS values of 846 and 1020 mg/l and were calcium-sulfate and sodium-sulfate water types respectively.

The proximity and hydraulic connectivity of Swift and Morrison aquifers to each other and to adjacent aquifers may give reason to expect water quality variability. The Lyman well appears anamolously high in TDS and sulfate and may be affected by AMD water. No log exists for the well but it is drilled on the very edge of the Sand Coulee Creek Valley which is known to be a source of AMD leakage to lower bedrock aquifers.

2.2.5.3 Kootenai Aquifer

The Kootenai aquifer is the surficial bedrock aquifer over most of the study area and receives recharge directly from precipitation and surface sources. Four water samples from the Kootenai aquifer were collected in this investigation.

Three samples were collected from the basal Kootenai sandstone aquifer, two from wells and one from a spring. The two well samples had TDS values of 369 and 433 mg/l and were a magnesium-bicarbonate type. The spring was located about 400 meters north of the Giffen mine works and had a TDS of 295 mg/l, and was a calcium-magnesium-bicarbonate type.

One sample came from a well also near the Giffen mine but located on the bench. The water-bearing zone was a limey sandstone about 65 feet below ground surface and about 50 feet above the basal Kootenai sandstone. The TDS was 369 mg/l and it was a calcium-magnesium-bicar-bonate type. The analyses are plotted along with the Jurassic well samples on a Piper diagram in Figure 9.

These results are similar to those of Wilke (1983) who sampled five Kootenai wells in the Great Falls vicinity and reported a TDS

range of 558 to 1,550 mg/l, with magnesium and bicarbonate being the principal constituents in three of the samples.

Total field alkalinity in the Kootenai samples ranged from 269 to 433 mg/l as CaCO₃ and field pH ranged from 6.63 to 7.48. Kootenai aquifer ground water is thought to be the principal source of leakage into old mine workings and hence is the water that becomes acidized. These analyses indicate that native Kootenai ground water is alkaline and of relatively good quality. The undisturbed Morrison coal bed is thought to be an aquitard and hence does not transmit appreciable quantities of ground water.

2.2.5.4 Quaternary Aquifers

The alluvial valleys of Sand Coulee Creek and tributaries contain ground water, although in most of the study area, it is not used domestically because of AMD contamination. Residents long ago abandoned alluvial wells and consequently there are very few existing alluvial wells. No alluvial wells could be found north of Stockett, and so no data could be collected on alluvial water quality.

The town of Stockett's alluvial collector well 2.5 miles south of Stockett was field checked in spring, 1981 and found to have a pH of 5.3. The alluvium there is up-gradient from most perennial AMD discharges, however, ephemeral AMD sources apparently discharge during wet weather, causing some seasonal contamination. Stockett residents complained of iron staining and bad taste during these occasions and in 1981 drilled a deep well to the Madison aquifer for a public supply. This has been the trend throughout the study area. Shallow alluvial wells have been replaced by deeper bedrock wells to escape AMD contam-

ination problems. However, as previously indicated, both Jurassic and Madison aquifers show evidence of contamination in selected wells.

Further suggestion of alluvial ground-water contamination came from rancher O. G. Johnson who lives about 2 miles north of Tracy. He reports that a number of shallow wells drilled across his property in Section 31 (T. 20 N., R. 5 E.) and Section 6 (T. 19 N., R. 5 E.) encountered only AMD affected water. As a result, they drilled deeper wells to the Madison aquifer but in at least one case, acid water disintegrated the cement grout and steel casing causing the well to be contaminated and abandoned.

Contamination of alluvial ground water may extend along the entire reach of the pre-glacial Missouri River, now occupied by Sand Coulee Creek. The extent of contamination will be mapped in a subsequent investigation by the MBMG and Montana Department of State Lands.

2.3 SURFACE WATER

2.3.1 Gaging Stations

Three gaging stations were installed within the Sand Coulee drainage in Fall, 1980. The three locations (Appendix D) are Sand Coulee Creek at Centerville, below the confluence with Cottonwood Creek (CF-03); Sand Coulee Creek at Tracy, above the confluence with Straight Creek (CF-02); and Straight Creek north of the town of Sand Coulee (AF-01). The stations were installed with modified 90 degree V-notch weir plates, having a 30 degree cutout at the base to a gage height of 1.12 feet. The 30 degree modification was designed to increase the resolution of low-flow determinations, up to a discharge of about 1 cfs.

Stevens Type A recorders were employed in the stilling wells. The Centerville weir accommodated flows up to 50 ft 3 /s (gage height 4.24 ft), while the Tracy and Straight Creek weirs could measure up to 13.4 ft 3 /s (gage height 2.83 ft). Design plans and rating equations used for the weirs are included in Appendix D (D-1).

Daily discharge data and stream hydrographs for the gaging stations are displayed in Appendix D (D-7). The short term data allow only tentative generalizations to be drawn, including:

1) Sand Coulee Creek shows high annual variability in discharge. During late winter and spring, its flow is dominated by runoff from snowmelt and spring rainstorms in the Sand Coulee area and in the upper reaches of the watershed in the Belt Mountains. In 1981, intense spring rainstorms in May caused flash flooding along Sand Coulee Creek in the Tracy-Centerville area, washing away the two original stilling well installations at CF-02 and CF-03. Peak flows fell gradually, and by October the main watercourse was essentially dry. It would not be unusual for Sand Coulee Creek to be dry by August in a year of "normal" precipitation and earlier in dry years. Bank and bed materials around these two stations were washed out a second time in May, 1982, again following a spell of very wet weather. The instability of the channel materials and limitations on station construction forced the abandonment of the sites. They could be reinstalled as open channel stations. Peak flows topped the weirs by over one foot (gage heights >5.0 feet).

Low flow periods exhibited both streamflow losses and gains between the Centerville and Tracy weirs. Concurrent streamflow records in November, 1981 indicated a possible loss of 5-15 gpm in that reach. An eleven day period in latter August, 1981 indicated very little change in flows at about 300 gpm.

2) Straight Creek, despite having a watershed area of only about 4 percent the size of Sand Coulee Creek, has baseflows similar in magnitude and sometimes of longer duration. Sand Coulee Creek was dry from November through March in water year 1981, while Straight Creek had base flows of 0-10 gpm. The AMD from the many abandoned mines tributary to Straight Creek is primarily responsible. During low flows most of the water in Straight Creek infiltrates to the alluvium before the confluence with Sand Coulee Creek.

Peak flow in 1981 occurred on May 16 and reached 21.6 ft 3/s. Summer flows generally ranged from 5.0 to 0.2 ft 3/s.

2.3.2 Seepage Profiles

A seepage profile can be viewed as an instantaneous detailed summary of variations in stream discharge throughout a watershed, although in practice the collection of this data takes as long as several days. In a stream like Sand Coulee Creek dominated by acid mine drainage, changes in water quality (pH, specific conductance, metal concentrations) also reflect variations in stream discharge and can point out stream gains or losses.

Acid mine drainage discharges into surface water systems and undergoes changes in both quality and quantity early in its downstream flow. Changes in surface-water quantity include losses, primarily streambed infiltration, and gains, primarly inflow from tributary drainages and seepage from shallow ground-water discharge. Changes in quality are primarily due to mixing with tributary streams and to precipitation reactions caused by oxidation of the acid water. Seepage profile data were collected to investigate these downstream changes in discharge and water quality and to relate them to the interaction of the ground water and surface water. All stream seepage profile sites are shown in Appendix D (D-2).

2.3.2.1 Number Five Coulee

The seepage profile on Number Five Coulee, conducted March 14, 1981 was terminated prematurely when a temporary restraining dam was breached. However, eleven measurements were made beforehand between the Giffen mine and the confluence with Cottonwood Creek. Streamflow measurements were made with a hand-held pressure-diaphragm current meter, readable to 0.1 ft/sec.

There were both gains and losses, but there appeared to be a tendency for decreasing streamflow possibly indicating losses to alluvium and bedrock. The net loss between successive measurements along the approximately four stream miles ranged from 24 to 104 gpm, and is depicted in Appendix D (D-3). The pH and specific conductance at the II sites remained relatively constant, with pH values from 6.05 to 6.68 and specific conductance values from 1159 to 1228 us/cm (see Appendix D (D-4 and D-5).

2.3.2.2 Sand Coulee-Cottonwood Creek

Seepage characteristics of Sand Coulee and Cottonwood Creeks were determined with 21 seepage run stations established from 8-26-81, 1500 hrs., to 8-29-81, 1000 hrs. (see Appendix D). These included tributary flows entering at DFO1 (Sand Coulee Creek), BFO1 (Number Five Creek), and AFO1 (Straight Creek), as well as 18 temporary stations installed along the main drainage of the area formed by Cottonwood and Sand Coulee Creeks (CF01-CF18). The three permanent gaging stations were included in the seepage profile. Discharge was measured at each station except these three using a portable reinforced plywood 90-degree V-notch weir, graduated in hundredths of a foot. At each station the weir was installed and leveled across the channel using clay and mud. The water level was allowed to rise to equilibrium behind the weir, at which time the gage height was noted. At stations where the stream gradient was high, equilibrium was achieved within a few minutes; under gentler gradients, slow rise in water level persisted for up to four hours. At all stations except one (CFOI), an equilibrium gage height was attained. The relative error of the technique is estimated at -5

percent. The field pH and S.C. were measured at each station. In addition, seven water quality samples were collected and analyzed for major element chemistry and for both total recoverable and dissolved metals (Appendix D, D-6). The discharge at AFO1 had been sampled and analyzed six weeks earlier, on 7-17-81, and in light of the low variability of discharge, conductance and pH between these two dates, the data from this earlier analysis were considered representative of AFO1 during the seepage profile.

The results indicate that about 1078 gpm of surface water was input and about 1065 gpm was lost from Sand Coulee Creek as channel seepage and evapotranspiration between the uppermost point 5 miles south of Stockett and the mouth of the creek at the Missouri River.

Evapotranspirational losses in warm months complicate the interpretation of seepage profile data. Diurnal fluctuations of hydrographs from gaging stations on Sand Coulee Creek and Straight Creek indicate peak evapotranspirational withdrawals of 20 to 30 gpm and average daily withdrawals of 9 to 14 gpm. An estimate of the total direct evapotranspirational withdrawal over the entire stream length under study was made by using an average stream width of 4.7 feet, a length of 24 miles (DNRC, 1979) and the August, 1981 average daily corrected evaporation rate of 0.0168 ft/day, a mean of the U.S. Weather Bureau's Canyon Ferry and Moccasin experiment station pan data (U.S. Dept. of Commerce, 1982). The average evapotranspirational loss rate from the stream was thus estimated to be 52 gpm, or about 2.17 gpm per stream mile.

The total net streamflow losses to ground water, by difference, equalled 1013 gpm. Using more conservative criteria, stream losses to

infiltration and ground water would be occurring, when between two consecutive measurements, a loss remains after obtaining the minimum difference of each pair of measurements <u>+</u> 5%, to allow for possible measurement error, minus 2.17 gpm/mi due to evapotranspirational effects.

Based on these criteria, seven of the eleven measured stream segments exhibited streamflow losses to infiltration ranging from rates of 7 to 108 gpm per stream mile. Losses to infiltration using the above criteria for all seven stream segments totaled 958 gpm. If all the gains in streamflow and evapotranspiration losses for the other four segments are subtracted, a net minimum overall streamflow loss to infiltration of 815 gpm remains.

A set of current meter measurements were made in August, 1982 to re-check stream seepage losses from several segments of Sand Coulee and Cottonwood Creeks. The results again confirmed a loss of about 100 gpm between Stockett and No. 5 Coulee on Cottonwood Creek. A very small gain was measured between No. 5 Coulee and CFO3 and a gain of 168 gpm measured between CFO3 and CFO2.

A flow measurement was made on upper Sand Coulee Creek (T. 17 N., R. 5 E., 7, BA) about 17.5 stream miles above Centerville. At that point the flow was 2.9 ft³/s, pH was near 7.0 and S.C. equaled 672 us/cm. Sand Coulee Creek at Centerville just above Cottonwood Creek discharged only 1-2 gpm, indicating that the mainstem of Sand Coulee Creek also loses substantial amounts of water to subsurface seepage.

Water quality data collected during seepage profiles (Appendix D (D-7)) indicate the major impact which AMD had on streamflow.

Cottonwood Creek above AMD influence had a pH of 7.33 to 8.26 and a

specific conductance of 418 to 476 us/cm. Downstream at Stockett, pH was 3.16 and S.C. equaled 1,641 us/cm. Just above Centerville, Cotton-wood Creek had a pH of 3.34 and an S.C. of 1,233 us/cm.

Sand Coulee Creek below Centerville had pH values ranging from 3.42 to 2.60, and S.C. values of 1,267 to 3,151 us/cm. The pH decreased below the confluence with Straight Creek, and S.C. showed a tendency to increase in the downstream direction, with the highest value just above the confluence with the Missouri River.

Effects of both evapotranspiration and acid neutralization reactions will increase the total dissolved solids concentration of the stream. Stream pH is affected markedly by both the influx of more acid or alkaline tributary water and by oxidation of dissolved ferrous iron to the rust-red ferric hydroxide precipitate which coats the channel of Sand Coulee Creek and produces additional acid.

2.4 Hydrologic Summary

The Sand Coulee Creek watershed has a dynamic hydrologic system in which the effects of acid mine drainage from abandoned underground coal mines plays a significant role in terms of volume and water quality impacts. Peak stream flows are of short duration and influenced primarily by spring and early summer rainstorms over the entire basin which extends to the Little Belt Mountains. Baseflow in streams originates primarily as ground-water discharge from the surficial Kootenai Formation, which is extensively fractured, and transmits meteoric recharge as ground-water flow to the contact with the underlying less permeable Morrison Formation, where springs and seeps contribute to streamflow. Where the Morrison coal seam has been mined, ground water leaks into the old workings where pyrite is oxidized, creating acid water which discharges to streams from old mine portals. From Stockett and Sand Coulee to the Missouri River, the baseflow of Sand Coulee Creek is primarily composed of acid mine drainage water. Very little of the acid baseflow leaves the watershed as streamflow, most of the water leaving either as evapotranspiration or being lost to subsurface seepage to alluvial and bedrock aquifers.

3. Chemical Modeling of Ground-Water Quality

3.1 Introduction

One of the significant discoveries of this project was the unanticipated poor chemical quality of ground-water sampled from some domestic wells in the study area. The dissolved solids, sulfate, and occasionally trace metal content of some Madison aquifer wells were much higher than the Madison ground water typically possessed even

farther down the flow system, namely, in the Great Falls vicinity.

The predominately downward vertical gradients, regional fracturing and solution permeability associated with the area create conditions favorable for leakage of acid mine drainage from contaminated streams and alluvium into lower aquifers, principally the Swift and Madison.

Chemical modeling calculations were conducted in an attempt to explain the mechanisms and dynamics of potential AMD contamination of the alluvial, Swift and Madison aquifers.

The primary objective of the modeling calculations was to provide some ideas on the constraints that equilibrium or near equilibrium mineral-aqueous phase relationships place upon the chemical composition of ground water. These results are then used to evaluate the mixing of various "type" waters. The result is a minimum and maximum value for the amount of acid mine drainage responsible for the impacted water quality of wells in the (deeper) Madison aquifer. The methodology employed is similar to that described by Plummer et al. (1983), using the program PHREEQE (Parkhurst et al., 1980). Acid-mine drainage from adit AS-03 was used as an end member type water. Two water samples, from the Kunesh and Net wells, were used as end member "uncontaminated" Madison type waters. The following sections describe the results of a pure mixing model and two different reaction models. We will compare the predicted product phases with cuttings from the planned 1983 drilling program to evaluate which of these models most closely resembles the natural system for further predictive input.

3.2 Mixing Model

The product of a mixing model is simply a synthetic water analysis

in which \underline{X} percent of water A is mixed with Y percent of water B (X + Y = 100) to yield a hypothetical water C, which is the best possible approximation of an observed water quality (water D). In order to accomplish this calculation, at least one constituent must be treated as "conservative," i.e., no additions or subtractions of this parameter occur. AS-03 drainage and the Kunish well water were used as waters A and B; sulfate, which constitutes the major anion species, was treated conservatively. The calculated mixing ratio is 19 percent AS-03 water and 81 percent Kunesh well water. Results of these calculations may be found in Table 3.

3.3 Reaction-Mixing Model 1

Because the mixing-model results provide a very poor correlation in terms of Fe, Ca, Mg, pH, and HCO_3 , a reaction model was used to evaluate the dissolution of limestone and dolomite by the acid mine drainage. Reaction steps for this model are: (1) precipitation of gibbsite and amorphous ferric hydroxide; (2) dissolution of calcite and dolomite plus precipitation of $\mathrm{Al}(\mathrm{OH})_3$ and $\mathrm{Fe}(\mathrm{OH})_3$; (3) degassing to atmospheric partial pressure of carbon dioxide ($\mathrm{P}_{\mathrm{CO2}}$); and (4) mixing 19 percent modified AS-03 water with 81 percent Knox water and increasing the $\mathrm{P}_{\mathrm{CO2}}$ to atmospheric. Results of this approach, shown as analysis E in Table 3, provide a reasonably good match with the water in the Knox well.

3.4 Reaction-Mixing Model 2

The major drawback to the first reaction-mixing model is that it ignored the supersaturation of the water with respect to gypsum.

Gypsum precipitation would remove sulfate from the water, thereby requiring a greater percentage of acid mine drainage to result in hypothetical mix water similar to that from an impacted well.

For this model, a low total dissolved solids well water (Net well), was used, and a less severely impacted Madison aquifer well (Senior Citizens well, Centerville) was the control well. Mass balance calculations were not used to control the mixing ratio. Instead, the modeling steps were: (1) react AS-03 water with limestone precipitating Fe(OH) $_3$, Al(OH) $_3$, and fluorite at saturation levels, precipitating gypsum at slightly supersaturated levels, releasing CO $_2$ once P $_{CO2}$ = 10 -0.75 atmosphere, and dissolving calcite until slightly undersaturated; (2) mixing water from the previous step with Net well water, dissolving a small amount of dolomite and precipiating small amounts of chalcedony and calcite. This procedure required 45 percent modified AS-03 water and 55 percent Net well water to approximately match the water quality in the Senior Citizens well.

3.5 Discussion

The models provide insight as to the probable range of mixing within the Madison aquifer of acid mine drainage waters with "pristine" ground water. The authors hypothesize that plumes of significantly degraded water within the Madison aquifer are probably restricted to the areas immediately down gradient from discharging mines, in the vicinity of leaky Madison well bores and near acid contaminated streams traversing Madison outcrops or alluvial subcrops.

4. Evaluation of Proposed Mitigation Alternatives

Previous analyses of acid mine drainage treatments for the Sand Coulee area (McArthur, 1970; Hydrometrics, 1982) focused on centralized neutralization or mine manipulation methods. Knowledge of the hydrodynamics and hydrogeology of the AMD problem gained in this investigation allows new evaluations of old techniques and the suggestion of some new mitigation alternatives.

Five AMD control techniques were proposed for field testing in the Stockett-Sand Coulee area based on this and previous work by the Montana Bureau of Mines (MBMG) and others. In addition to being summarized below, the five methods were presented on a proposal to the Montana Department of State Lands (DSL) (Appendix E). They subsequently agreed to provide funding for field testing of two methods: infiltration control through increased evapotranspiration and drainage wells.

An investigation of the extent of acid mine drainage contamination in the alluvium of the lower Sand Coulee Creek watershed was proposed and also funded by DSL for 1983-84.

4.1 Infiltration Control

A minimum of two test sites are proposed to monitor the effectiveness of perennial deep-rooted crops (eg. alfalfa and sanfoin) and flexible-cropping techniques in reducing ground-water recharge to the
Kootenai aquifer overlying the old coal mine workings. Research in
dryland saline-seep control has shown intensive cropping techniques to
be an effective tool in the control of shallow ground-water flow systems, when applied with a sound farm management plan. An organization
such as the Triangle Conservation District, Conrad, Montana, would
supply the required farm plan expertise to the farmers involved. Moni-

toring of ground-water level trends and of key AMD discharges would quantify the effectiveness of this approach.

4.2 Drainage Wells

Dewatering of the Kootenai aquifer with vertical wells may be possible, but is undesirable due to long-term pumpage requirements. We propose that horizontal test wells be drilled into the basal Kootenai sandstone aquifer upgradient from old mine workings at two sites.

Gravity drainage of Kootenai ground water will eliminate pumpage, may substantially reduce AMD discharge of the test sites and will make more fresh water available for dilution of remaining AMD in receiving streams. Horizontal dewatering wells have been used successfully in Montana for highway construction and mining purposes in the past.

Vertical connector wells which would allow gravity drainage of Kootenai ground water to the Madison aquifer, are another alternative which may be tested once detailed information on the aquifers and old mine workings is developed. Vertical test hole drilling and geophysical techniques would be used to map the location of old mine workings.

4.3 Subsurface Injection of AMD

Madison limestone rocks underlie the entire Sand Coulee watershed and could be an effective decentralized, disposal and neutralization medium for AMD. However, the Madison is also an important aquifer that must not be adversely impacted. Logging, sampling and analyses of Madison rocks from several test wells will indicate its physical characteristics. Aquifer testing and water quality sampling will be done to determine initial permeability characteristics estimate end products of

mixing AMD and Madison water. An initial 10-day injection test, and a second 100-day test would be conducted during which time extensive water quality and ground water level monitoring would be done. Following the tests, geophysical logs would be re-run on the test holes, aquifer test re-run to determine permeability changes and at least two new bore holes drilled and cored to sample precipitates. Hydrochemical modeling would be done to predict the long-term feasibility and impacts of an injection program.

4.4 Flyash Neutralization

MBMG studies have documented the effectiveness of flyash in neutralizing pyrite induced acidity and reducing iron mobility of mine tailing waters (Sonderegger and Donovan, 1982). A field test of the effectiveness and maintenance requirements of a small flyash pit in neutralizing small acid discharges in the Sand Coulee area would be conducted. Pits of about 200 ft³ in size would be filled with flyash and acid inflows of 1 gpm or less allowed to seep upward through the pits, being neutralized prior to discharge from the lower end. Water quality sampling and pit excavations would establish the effectiveness of the technique.

4.5 Kootenai Neutralization

A simple and possibly effective AMD neutralization technique would be to mix naturally alkaline Kootenai ground water with small volumes of acid mine water. Mixing would occur in a pit where metals would be allowed to precipitate prior to discharge of the effluent. Typical AMD acidity and Kootenai ground-water alkalinity requires a 1 to 10

volumetric mix for theoretical neturalization. The technique will be evaluated by taking water quality samples and field measurements of the inflow and outflow.

4.6 Alluvial Ground-Water Contamination Mapping

The alluvial valley of Sand Coulee Creek joins an abandoned pre-glacial channel of the Missouri River. Residents all along lower Sand Coulee Creek abandoned alluvial wells years ago due to AMD contamination and even the Madison aquifer is contaminated in places. The many years of AMD seepage losses along the seven miles of old Missouri River alluvium have had a so-far undocumented impact on shallow ground-water supplies in the Great Falls area. It is proposed to conduct a reconnaissance shallow well drilling and sampling program in the old channel to document the extent of AMD contamination. Ground water flow gradients and the extent and severity of water quality conditions would be mapped.

5. Summary

The numerous abandoned underground coal mines in the Stockett-Sand Coulee area discharge a combined rate of 1-4 ft³/s of acid water (pH = 2-5) with a high dissolved and suspended metal load. The sources of the water is primarily downward leakage from the surficial Kootenai formation. The acid water comprises 60-90 percent of the total flow of Sand Coulee Creek in baseflow periods. Most of this flow is lost to evapotranspiration and leakage to alluvial and deeper bedrock aquifers, namely, the Swift sandstone (Jurassic) and Mission Canyon limestone (Mississippian) of the Madison group rocks.

Cround-water quality in the Kootenai aquifer is good, with TDS in the 300 to 450 mg/l range and alkalinity averaging about 340 mg/l as CaCO₃. Water in the alluvium, downgradient from discharging acid sources is mostly contaminated such that very few domestic wells utilize this source. Water quality in the Swift and Madison aquifers is variable with unexpectedly high TDS and sulfate concentrations (maximum TDS = 2,413 mg/l, maximum sulfate = 1,580 mg/l) sampled in some domestic wells. This is believed to be caused by mixing with downward leaking AMD water from alluvium, well bores and places where contaminated streams traverse outcrops of Madison rocks.

A combination of AMD treatment techniques may prove to be the best long range mitigation approach. Five control measures were recommended for field testing: 1) infiltration control using intensive cropping methods in recharge areas; 2) connector and horizontal wells to dewater the Kootenai aquifer overlying the old mines; 3) injection and neutralization of acid water in the Madison limestone; 4) neutralization of small AMD sources in flyash pits; 5) neutralization of small AMD sources in pits with naturally alkaline Kootenai ground water.

TABLE I Correlations of Mine Designations Used in the Sand Coulee drainage.

MBMG No.	Location	Name	McArthur No. 5	Hydrometrics No
¹ AS-01	19N04E23ADCB	Upper Carbon Mine	23-6	SCM-2
AS-02A	19NO4E23ADAB	Lower Carbon Mine	23-5	SCM-3
AS-02B	19NO4E23ADAB	Lower Carbon Mine	23-5	
AS-04	19NO4E14DDED	Brown Mine	14-1	SCM-5
AS-06	19NO4E13CBA			
2 ^{AS-07} 3 ^{BS-01} 3 ^{CS-01A}	19NO4E13CBD	Nelson Mine	13-3	SCM-6
2BS-01	18NO4E14ACD	Giffen Mine	14-16	SCM-4
³ CS-01A	19N05E07CACD	Tracy Mine	7-2	SCM-8
CS-01B	19NO5EO7CACD	Tracy Mine	7-2	SCM-8
CS-02	19NO5E07DBC			
CS-03	19N05E18A			
CS-04	19NO5E18DDC			
CS-05	19NO5E19ACD			
CS-06	19N05E18DCC		13-6	SCM-11
CS-07	19N05E19BAA			
CS-08	19NO5E19ABB			
CS-09A	18N05E06CDB	Number 6 Mine	6-1	SCM-9
,CS-09B	18NO5E06CDB	Number 6 Mine	6-1	
4DS-01	19N05E20BBB			
SCM-7	19N05E07ABD	Badwater Johnson Mine	7-9	SCM-7
SCM-15	19N05E07AAAA	Goodwater Johnson Mine	7-8	SCM-15

A: Straight Creek

³ B: Number Five Coulee

C: Sand Coulee Creek below Centerville D: Sand Coulee Creek above Centerville

⁶ McArthur, 1970 Hydrometrics, 1982

TABLE 2
Acid Discharge Characteristics, 1980-83

		Observed Rang	ge
	Flow		S.C.
Site	(gpm)	рН	_us/cm
AS-01	43-500	2.21-3.01	4679-5349
AS-02a	7-26	1.99-2.82	2316-8047
AS-03	0-5	2.48-2.79	5363-6974
AS-04	45-67	3.84-4.20	3083-3487
AS-05	0-50	2.90-3.42	3352-3406
AS-06	0-38	2.80-3.10	1701-3469
AS-07	12.5-250	2.21-3.67	5023-10,306
BS-01	150-351	3.44-5.41	1038-8652
CS-01	14.3-39.7	2.28-2.88	1487-2103
CS-02	0-4.8	2.85	1387-1817
CS-06	0-0.61	3.45	8892
CS-07	1.1	2.27	15,732
CS-09	10.0-38.1	2.25-2.60	4865-7365
CS-10	0-80	1.50-2.55	10,114-10,591
DS-01	0-6	2.80	2283
SCM-7	5-15	2.3-2.35	2820-4243
SCM-15	3.8-7	3.02-6.3	1004-1100

Table 3. Major Element Water Chemistry for Modeling AMD Contribution to Impacted Wells.

	A AS-03	B Kunesh	C Synthetic	D Knox	E Reaction	F Net Se Well Cit	G Senior Re	H Reaction
		T T AM	V TIJ	T T DM	ומרוו ז			3 - 11 - 2
Lab No.	8100057	79M3253		8101088	8	8200499 830	8300001	
Ca	292.	79.9	120.2	487.	456.	65.5	241.	204.
Mg	190.	32.	62.	146.	121.	23.6	135.	123.
Na	17.1	10.1	11.4	28.9	11.4	7.1	23.1	11.7
×	1.1	2.3	2.07	7.5	2.1	3.1	4.1	2.2
F. e	. 944.	0.05	179.	0.15	0.045	0.018	<.002	0.012
Mn	2.84	4 0.00	0.54	0.016	0.53	0.002	0.004	1.292
Si0 ₂	116.	10.9	30.9	19.8	30.6	15.7	16.9	12.0
нсо3	1 1	235.	190.	261.	343.	271.	440.	636.
C1	2.0	4.9	4.3	5.1	4.4	3.1	23.3	2.6
SO4	7700.	145.	1580.	1580.	1562.	65.7	755.	747.
NO3(as N)	1.7	0.32	0.58	9.04	1 1	5.69	12.4	spe one sp
(یر	12.8	0.57	2.89	99*0	97.0	0.50	1.1	0.85
рН	3,38	8 7.4	4.10*	6.33	7.60	7.12	5.7	6.82
TDS	9280.	402.	2087.	2413.	2358.	324.	1411.	1417.
* pH = - 1	pH = - log ₁₀ (0.19	9 x 10 ^{-pH} A)) + (0.81 x	10 ^{-p} HB)				

TABLE 4
Selected Well Inventory Data for the Sand Coulee Area

NO. 1	AQUIFER	LAND ELEVATION ft, msl	TOTAL DEPTH ft	STATIC WATER LEVEL ft, msl	S.C.	DATE MEASURED ²
)1	Alluvium	3800	35	3784.02	983	6-4-82
(1	Kootenai	4303	90	4228.12		8-19-82
:2 :3	Kootenai Kootenai	4075	131 75	4057.32 4356.18	677 506	6-21-82 8-19-82
1	Jurrassic	3695	58	3665.52		6-2-82
12	Jurrassic	3390	100	3365.27	1336	5-27-82
(1	Madison Limestone	3440	158	3338.64	612	6-9-82
12	Madison Limestone	3430	168	3320.22	700	6-18-82
13	Madison Limestone	3457	175	3374.44	595	6-5-82
14	Madison Limestone	3455	220	3448.67	1667	6-4-82
15	Madison Limestone	3460	185	3311.32	617	6-10-82
16	Madison Limestone	3455	175	3375.24	597	6-19-82
17	Madison Limestone	3475	200	3352.08	2292	6-9-82
18	Madison Limestone	3510	290	3313.1	826	6-20-82
19	Madison Limestone	3490	258	3408.3	2911	6-2-82
110	Madison Limestone	3400	125	3334.19	1698	5-28-82
111	Madison Limestone	3418	200	3345.85		5-28-82

Refers to Figure 6.

All measurements by MBMG.

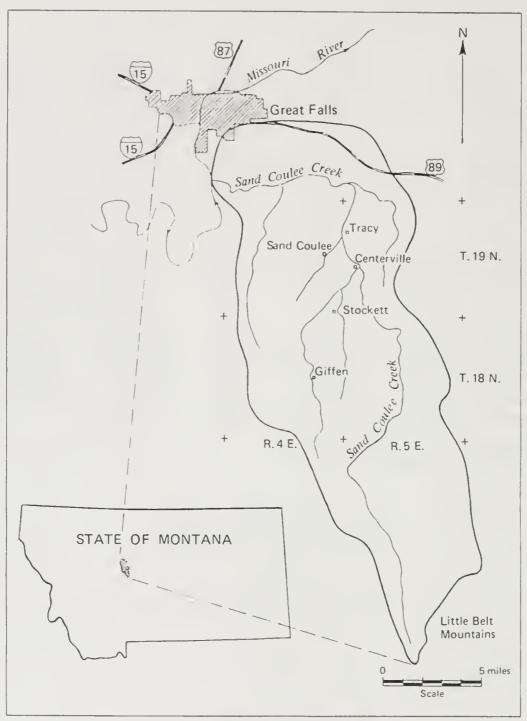


Figure 1. Location of study area.

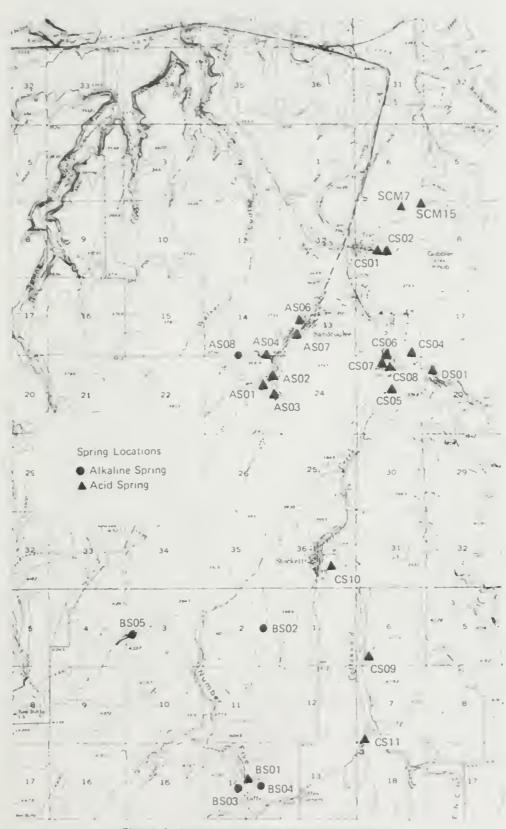


Figure 2. Location of springs and acid discharges.

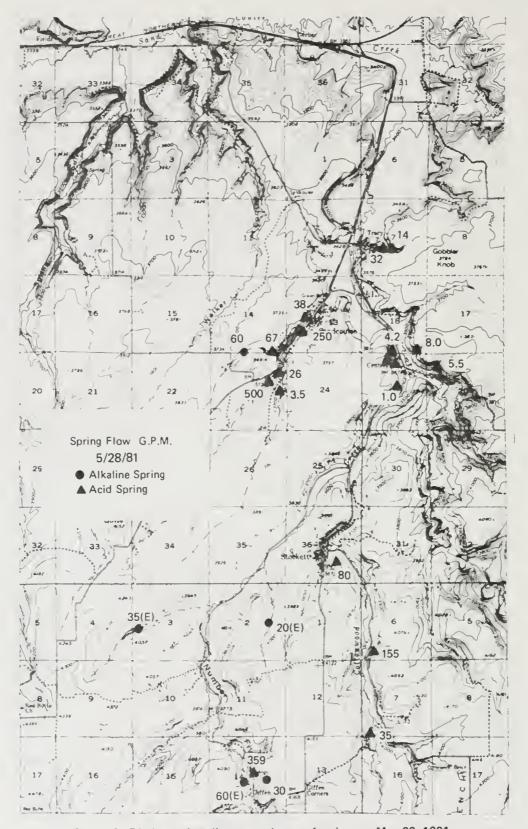


Figure 3. Discharge, in gallons per minute, of springs on May 28, 1981.

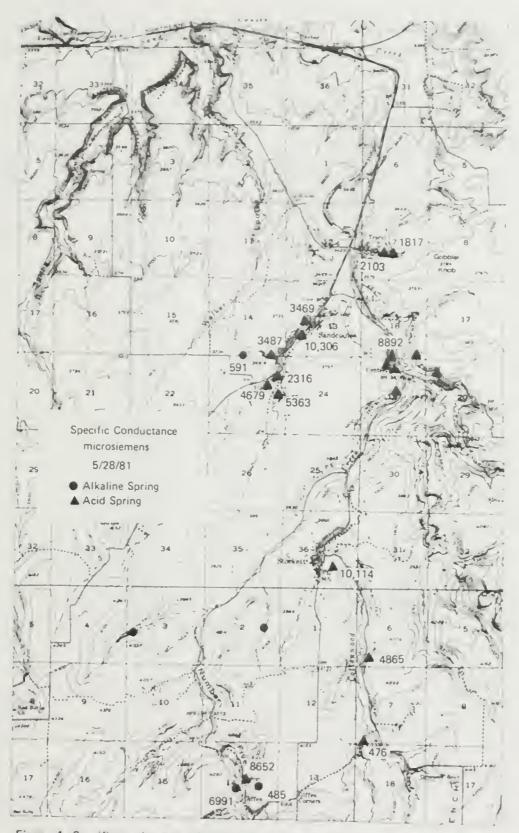


Figure 4. Specific conductance of springs in microsiemans/cm (μ S/cm) on May 28, 1981.

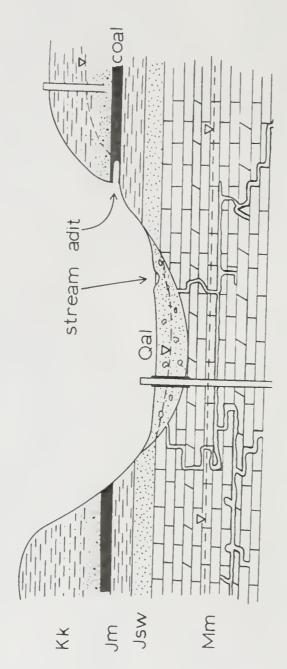


Figure 5. Schematic cross section through a coulee. Not to scale. Kk=Kootenai Formation; Jm=Morrison Formation; Jsw=Swift Formation; Mm=Madison Group. Thickness of the coal and the Swift Formation are exaggerated. The symbol abla represents the water table.

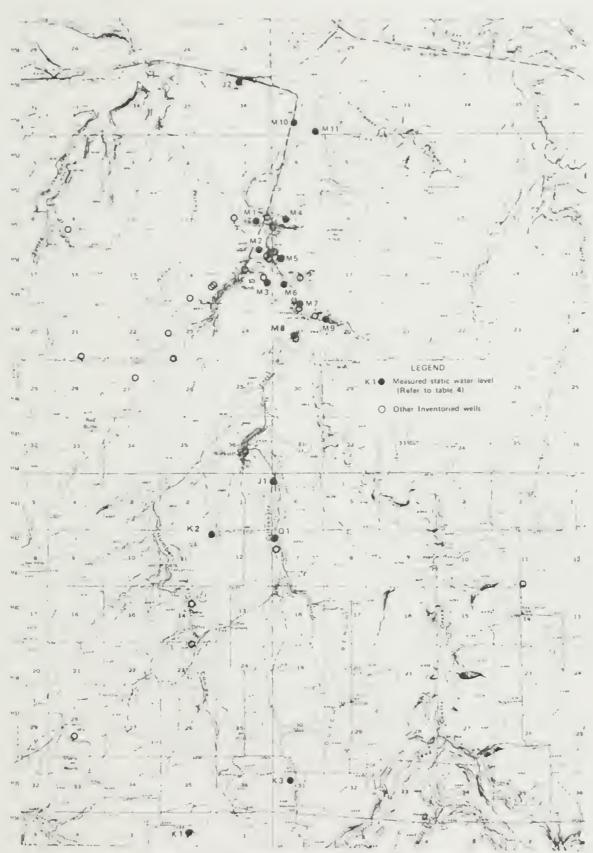


Figure 6. Location of domestic wells inventoried by MBMG, 1982.

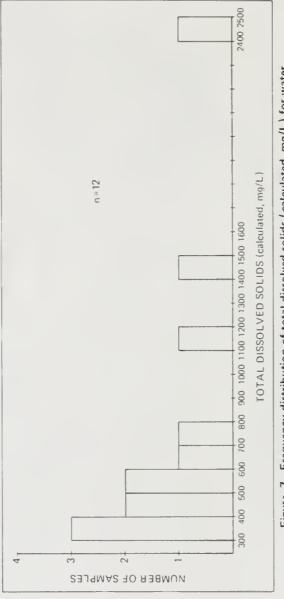


Figure 7. Frequency distribution of total dissolved solids (calculated, mg/L) for water samples from the Madison aquifer, Sand Coulee area, Montana.

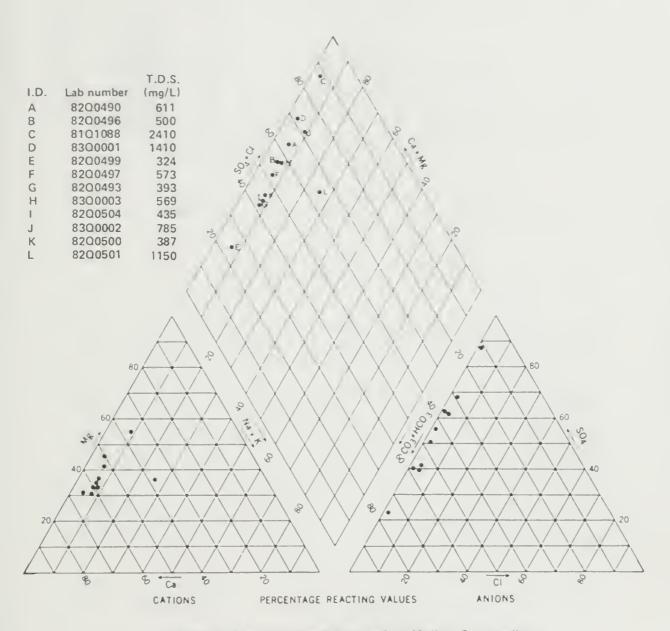


Figure 8. Piper plot of water analyses from Madison Group wells, Stockett - Sand Coulee area, Montana.

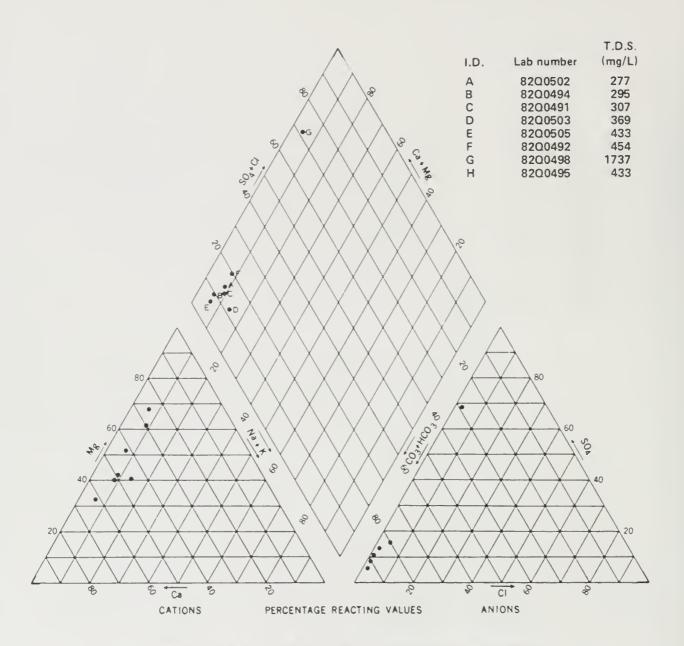


Figure 9. Piper plot of water analyses from Jurassic and Kootenai wells, Stockett-Sand Coulee area, Montana.

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APPENDIX A SPRING AND ACID DISCHARGE DATA

A-1

SPRING MONITORING DATA

		SC		198	1	472		1							1
1	A508	111111111111111111111111111111111111111		8.48	1	8.45	1								
	AS	FLOW		21	1	300	1 1	1							
C		SC		6362	7152	1030	5023	5577	5622	5667					-
@ 25	AS07	na		2.38	2.50	3.67	3.20	2.35	2.21	2.40					
Reference permit ita (micro-mhos/cm	AS	SC GPM		170140	112.5	9 250	2762 69.8	340640,E	31	07 22.E					_
Reference ro-ml	-	Š			1781	3469				2007					_
ata (mic	AS06	200 200 200		3.02	3.10	2.80	2.99	2.90		2.80			-		_
Monitoring Data imated value its in µS/CM (m		FLOW		9 1.2	70.7	0 38	32.9	- 0		2.2					
nitor ated s in	_	SC		3329	3287	2490	3083	2380	•	3225	1	1		1	
Spring Monitor E = estimated	A504	Hd		3.84	3.84	4.12	4.20	3.70		4.20					
		FLOW	m	4 29	2 35	3 67	4 18.6	4.5		14.1					
remarks:		SC	6673	5414	6622	5363	6974								_
	A503	- E	2.79	2.62	2.48	2.59	2.67								
Heli tilled in Heli sifted in Hele plugged by Ice or snow Sighen in hele	AS	FLOW	1	Ω.	1.58	3.5	2.7								
helin tedin upped by in hote		SS	8047	5689	7045	2316	5201	6498	7173	6786	1				
Heat, fulled in their suffed in Hole pulged b Saphon in bole	32	Hd	2.36	2.46	2.47	2.82	2.77		1.99	2.37				1	
14 Si	AS02	FICO	1	7	10.2	26	18	10.1	10.2	11.6					
ulee Valve above 08 Flote abandoned Dry North Seetl		SC	5231	5102	5349	4679	4989	1	5172	5055					
Coulee Valveabu A = Holeabur D = Dry hole F = Ulowloge		HC	3.01	2.62	2.64	2.85	2.81	i i	2.21	2.55					
	AS01	FLOW		103	43	500	375	t I	124	94					A-1
Sand Sand ('sding abbreviations:	Well Mo.	G S – MP	6/1-6/3/80	9/21/80	3/5/81	5/28/81	8/18/81	2/5/82	12/30/82	3/6/83					SHEETE 1 122

- Control of the state of

liv (cy Diviso JN Page -		SC Temp SWL SC Temp											
Appendix Riference point		SWL SC Temp SWL											
ALCTUATIONS - ring Monitoring	BSO4	GPM pl ¹ SC	Dry	Dry	Dry	30 8.08 485							
3 0	S02	Tow ph Sc F	20E 3.48 699 D	Dry	Dr. y D								
CLOLOGY Area Area oned St. HG, either in oned St. HG, either in	BS03	S Hd MAS	8.48 699			2	6	4 159 5.85 1575	2	3			
Sand Coulee Mins AND GLOLOGY Sand Coulee May 68 F1 A = Mole abandoned S1 D = Dry hole	BS01	V PH SC	5.36 1738	5.41 1122	5.39 1038	4.21 8652	3.44 2039	4.05 1684	4.48 1252	4.65 1173			
Caling abbreviations:	Well 10.		6/1-6/3/80	9/21/80 150	3/5/81 225	5/28/81 359	8/18/81 351	2/5/82	12/30/82 316	3/6/83 224			

6747 6923 3610 6283 6784 6257 6226 49 g 2.55 55 53 39 52 CS09 110 2. d 2 2 0 2 N 21.6 20.8 5 155 9 g 38 SC 1 S SEE DRY DRY DRY H CS07 J 7246 5114 8892 SC 3,45 7 3.21 DRY DII ł 2 9080 Remarks: Spring Monitoring Data 0.6 20 G 4.5 2 SC 1 1 SEEPS DRY DRY Hd CS05 1 F-F-F-F-F Fest vite 1 SC 1 FLOWING Ha DRY DRY 1 CS04 51 - Heb full din
51 - Heb allted in
1 - Hole plugged by the or snow
5 - Sigbon in bole 1 1 1817 1954 SC 2.82 85 DRY DRY Md. CS02 DRY 1 2 111.4 Chick 4.8 2.2 1 1 Coding abbitrations: • • Valve above GS

A • Hole abandoned

D • Dry hole

F • I fow for a city 1635 1746 1862 1490 1528 1752 1487 SC Sand Coulee Hd 2.65 2.88 2.90 2.77 98 2.88 2.75 2 CS01 33.8 14.3 36.1 39.7 38.2 55 E 20 E 6/1-6/3/80 12/30/83 9/21/80 GS-MP 5/28/81 8/18/81 hell No. Dofe 3/5/81 2/2/82 3/6/83

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MESTE 1 122 A-3

Appendix

WALLET THE CHUALIONS

6.51-879 6.5		D = Dry bole Filowing well	Mole abandoned Dry bole Towning well	- 0	Hele plugged by ice or se	d in ged by hole	ice or snow	>	1			1 1				1 1 1 1	1			1 1
Second S		S10		Ď	501		CSO	00	SCN	1-7	-	SC	M-15				_			
80 2.29 5800 DRY DEY DEY OF STATE OF ST		ЬН		MONT WOM WM		1 1	Tow		CPW	ЬН		F100W	hd	SC	S × L	သိလ	Temp	3 €	SC	Temp
PRY 40 DRY DEY 80 2.29 6800 14.1 2.55 1059 0.3 1.50 10548 12 6.0 2.80 2283 Dry 13.7 2.35 424 3.8 5.55 1100	-6/3/80	DRY		-		1														
80 2.29 6800	1/80	DRY		40																
80 2.29 6800 4.1 2.55 1059 0.3 1.50 10548 1.2 6.0 2.80 2283 Dry 13.7 2.35 4245 3.8 5.55 1100		DRY			ORY		Dry							- Allering						
14.1 2.55 10591		.29	6800																	
0.3 1.50 1054\$ 82 6.0 2.80 2283 Dry 13.7 2.35 4242 3.8 5.55 1100	4.1	1	1059																	
6.0 2.80 \$283 Dry 13.7 2.35 4245 3.8 5.55 1100	0.3		10549																	
, 6.0 2.80 2283 Dry 13.7 2.35 4243 3.8 5.55 1100	/30/82		1																	
				0.9	2.80	2283	Dry		(0)		424	1 • 1	5							
									•											
															وم					

SPRING WATER QUALITY LABORATORY ANALYSES

BUITE HONTANA 59701 (406)498-4101

WATER QUALITY SMALYSTS EAU NO. 8002316

STAFE HONIANA
LATITUDE-LONGITUDE 47D23/12:N 111D10/49:W
UTH COORD(NATES 212 N5247870 E486410
TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1
GEOLOGIC SOURCE 221MRSN* * * YINUOS HOLTADOL SITE CASCADE 19N AF 23 ADGE SC AGO1 472312111104901 MINE DRAINAGE TOPOGRAPHIC HAP GFOLOGIC SOURCE DRAINAGE BASIN STATION IN SAMPLE BB LAND SURFACE ALTITURE 3500. FT SUSTAINED YIELD
SUSTAINED YIELD
YIELD MEAS METHOD
TOTAL DEPTH OF WELL
ABOVE (-) OR DELOW GS
CASING DIAMETER
CASING TYPE
COMPLETION TYPE AGENCY + SAMPLER BOTTLE NUMBER MBHG*JJD AS-01 HATE SAMPLED 20-SEP -80 TIME SAMPLED 09:00 HOURS SWL LAR F ANALYST DATE ANALYZED SAMPLE HANDLING MBMG #FNA 09-MAR-81 4120 HETHOD SAMPLED GRAB PERFORATION INTERVAL WATER USE UNUSED

SAMPLING SITE SAND COULEE MINING DISTRICT*NO-NAME CREEK BEOLOGIC SOURCE MORRISON FORMATION

CALCIUM (CA) HAGNESIUM (MG) SODIUM (NA) FOTASSIUM (K) IRON (FE) HANGANESE (HN)	MG/L 190. 122. 19.4 	10.04 0.84 0.01 38.25	BICARRONATE CARBONATE CHLORIDE SULFATE HITRATE FLUORIDE	(H003) (C03) (CL) (S04) (AS N)	HG/L 4800: -01 4.20	0.07 75.77 0.00 0.22
TOTAL CATIONS	88.6	53.69	PHOSPHATE TOTAL	(AS F) ANIONS		95.08

STANDARD DEVIATION OF ANION-CATION BALANCE (SIGNA)

LABORATORY PH 2.70 TOTAL HARDNESS AS CACO3 976.58
FIELD WATER TEMPERATURE 10.0 C TOTAL ALKALINITY AS CACO3
CALCULATED DISSOLVED SOLIDS SODIUM ADSORPTION RATIO 0.27
SUB OF DISS. CONSTITUENT RYTHAR STABILITY INDEX
LAB SPEC.COND.(MICROMHOS/CM) 4568. LANGLIER SATURATION INDEX

PARAMETER	VALUE	PARAMETER	VALUE
TEMPERATURE, AIR (C)	13.0 0	CNDUCTVY, FIELD MICROMHOS	5102.
FIFLD PH	2.62	ALUMINUM, DISS (MG/L-AL)	393.
NICKEL, DISS (MG/L AS NI)	3.96	SILVER:DISS (MG/L AS AG)	:.002
LEAD.DISS (MG/L AS PR)	<.04	BURON → DISS_(MG/L AS B)	.16
STRONTIUM+DISS (MG/L-SR)	. 95	CADMIUM:DISS(MG/L AS CD)	.011
TITANIUM DIS(MG/L AS TI)	• 0 6 5	CHROMIUM; DISS (MG/L-CR)	.27
VANARTUM, DISS(MG/L AS V)	. 34	COPPER:DISS (MG/L AS CH)	. 15
ZINC:DISS (HG/L AS 7N)	17.6	LITHIUM, DISS(MG/L AS LI)	.52
ZIRCONIUM DISCHG/L AS ZR	.040	MOLYBRENUM: DISS(MG/L-NO)	.03
ARSENIC: DISS(UGZL AS AS)	30.4	MERCURY DISS(UG/L AS HG)	0.03
SELENIUM, DISS (UG/L-SE)	1.7	ACIDITY, TOT (MG/L-CACO3)	4695.

REMARKS: FINE WHITE PRECIPITATE IN WATER -BECOMES DRANGE PRECIPITATE UPON REACHING CREEK * MINE OUTFLOW - HEAD OF NO-NAME COULEF (SITE AS-01) * LAB: H+=41.1 MG/L * 40.7 MEOV/L, SIGMA -10.3, 1J4 TOTAL CAJION MEOVS/L *

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MER/L = MILLIFOUTVELENTS PER LITER. FT = PEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED, IR = TOTAL RECOVERABLE. TOT = TOTAL.

QW WA 52 WI OW PW AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST FRIT RATE: 04-MAY-81 RY: TF *CLG
PROCESSING PROGRAM: F1730F V2 (11/3/61) PRINTER: 27-MAY-83

PERCENT MEG/L (FOR PIPER PLOT)
CA MG NA K CL 904 HC03 C03
46.5 49.3 4.1 0.0 0.1 29.9 0.0 0.0

WATER QUALITY ANALYSIS LAB NO. 81R1086

```
STATE MONTANA
                                                                                                                                                                                                                  COUNTY CASCADE
       LATITUDE-LONGITURE 47D23'12'N 111D10'49'W SITE LOCATION 19N 04E 23 ADCB
UTH COORDINATES 712 N5247890 E486410 HBMG SITE AS01
TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1 STATION ID 472312111104901
                                                                                                                                                       # SAMPLE SOURCE
LAND SURFACE ALTITUDE
SUSTAINED YIELD
               UTH CUURDANT HAP SUUTION TOPOGRAPHIC MAP SUUTION TOPOGRAPHIC MAP SUUTION TO S
                                                                                                                                                                                                                                          472312111104901
MINE DRAINAGE
3500. (10
                                                                                                                                                          TOTAL DEPTH OF WELL
ABOVE(-) OR BELOW OS
CASING DIAMETER
CASING TYPE
COMPLETION TYPE
                   LAR + ANALYST HRMG
BATE ANALYZED
SAMPLE HANDLING 4220
METHOD SAMPLED GRAD
                                                                               UNUSED
                                                                                                                                                           PERFORATION INTERVAL
                                          WATER USE
                   SAMPLING SITE SAND COULEE HINING DISTRICT*NO-NAME CREEK GEOLOGIC SOURCE HORRISON FORMATION
                                                                                    MG/I.
                                                                                                                        MERZI.
                                                                                                                                                                                                                                                 HG/I.
                                                                                                                                                                                                                                                                     HE G / L
                                                                                                                            8.63 BICARBONATE
10.04 CARBONATE
                                                                                    173.
                                                                                                                                                                                                          (HC03)
                                                                                                                                                                                                                                                        .0
               CALCIUM
                                                     (CA)
                                                                                                                                                                                                            (003)
                                                                                                                                                                                                                                                            .0
               MAGNESIUM (MG)
                                                                                   13.1
                                                                                                                                                                                                                                                                                0.18
100.75
0.06
0.43
                                                                                                                            0.70 CHLORIDE
                                                                                                                                                                                                                                                         5.5
                                                                                                                                                                                                                (CL)
                SOBIUM
                                                      (NA)
                                                                                                                            0.01 SULFATE
46.25 NITRATE
0.07 FLUBRIDE
                                                                                                                                                                                                                                             4839.
               POTASSIUM (K)
IRON (FE)
MANGANESE (MN)
                                                                                        .27
                                                                                                                                                                                                               (SO4)
                                                                                    331.
                                                                                                                                                                                                           (AS N)
                                                                                                                                                                                                                                                         8.12
                                                                                                                                                                                                                     (F)
                                                                                                                                                   PHOSPHATE TOT (AS P)
                SILICA (SIG2)
                                                                                                                                                                                                                                                                                 101.42
                       TOTAL CATIONS
                                                                                                                            65.70
                                                                                                                                                                                   TOTAL ANIONS
                       STANDARD DEVIATION OF ANION-CATION DALANCE (SIGNA)
                                                                                                                                                           TOTAL HARDNESS AS CACO3
TOTAL ALKALIBITY AS CACO3
SODIUM ADSORPTION RATIO
                                                              LABORATORY PH
                                                                                                                                2:56
12:1
                                                                                                                                                                                                                                                                        534.13
        FIELD WATER TEMPERATURE
CALCULATED DISSOLVED SOLIDS
                                                                                                                                                                                                                                                                                0.23
                                                                                                                                                         RYZNAR STABILITY INDEX
LANGLIER SATURATION INDEX
                   SUH OF DISS. CONSTITUENT
SPEC.COND.(MICROMHOS/CM) 5157.
                                                                                                                                                                                                                                                                       VALUE
                            PARAMETER
                                                                                                                 VALUE
                                                                                                                                                                                   PARAMETER
                                                                                                                                                       CNDUCTVY, FIELD MICROHHOS ALUMINUM, DISS (MG/L-AL) SILVER, DISS (MG/L AS AS)
                                                                                                                 20.0
                                                                                                                                                                                                                                                                     5357.
 TEMPERATURE, AIR (C)
                                                                                                                                                                                                                                                                     433.
 FIELD PH
FIELD PH
NICKEL, DISS (MG/L AS NI)
LEAG, DISS (MG/L AS PB)
STRONTUM, DISS (MG/L AS TI)
VANABIUM, DISS (MG/L AS TI)
VANABIUM, DISS (MG/L AS V)
ZINC, DISS (MG/L AS ZN)
ZIRCONIUM DIS (MG/L AS ZR
IRON, TR (MG/L AS FE)
ALUMINUM, TR (MG/L AS AL)
4
                                                                                                                   4.32
                                                                                                           4.32

.004

.93

.024

.35

18.7

<.004

855

466
                                                                                                                                                                                                                                                                      <.002
                                                                                                                                                       SILVER, HISS (HG/L AS AS)
BORON , DISS (HG/L AS B)
CADHIUH, DISS (HG/L AS CU)
CHROHIUH, DISS (HG/L AS CU)
COPPER, DISS (HG/L AS CU)
LITHIUH, DISS (HG/L AS LI)
                                                                                                                                                                                                                                                                            084
                                                                                                                                                                                                                                                                            23122
                                                                                                                                                        HOLYBDENUH, DISS(MG/L-MD)
                                                                                                                                                        SELENIUM, TR (UG/L AS SE)
ACIDITY, TOT (HG/L -CACO3)
                                                                                                                                                                                                                                                                 4060.
                                                                                                             466.
```

REMARKS: WATER VERY FROTHY AND FOAH COVERED AFTER DISCHARGE HINE OUT FLOW, HEAD OF NO-NAME COULEE (SITE AS-01) H+ OF 81.73 MG/L GIVES 100.5 MED CATIONS GIVES .6 SIGHA

EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, HER/HILLIEGUIVELENTS PER LITER, FT = FEET, HT = HETERS. (H) = HEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

QW WA SO WI OW PW AT OTHER OTHER AVAILABLE DATA Y OTHER FILE NUMBERS: 8002314

PROJECT: COST:
LAST EDIT DATE: 19 FEB-82 BY: TP *UKS
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT MERZL (FOR PIPER PLOT)
CA MG NA K CL SO4 HC03 CO3
44.6 51.8 3.6 0.0 0.2 79.8 0.0 0.0

STATE HONTANA COUNTY CASCADE LATITUDE-LONGITUDE 47D23'21'N 111D10'30'N SITE LOCATION 19N 4E 23 AADC UTH COGRDINATES 712 NS248190 E486575 HRNG SITE AS-02 TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1 STATION ID 472321111103801 GFOLOGIC SOURCE 221NRSN* * SAMPLE SOURCE MINE BRAINAGE GEOLOGIC SOURCE 22 DRAINAGE BASIN BB LAND SURFACE ALTITUDE 3570. FT . 10 DRAINAGE BASIN BB
AGENCY + SAMPLER MBMG*JJD
BOTTLE NUMBER AS*02
DATE SAMPLED 20*SEP*80
TIME SAMPLED 09:30 HOURS
LAR + ANALYST MBMG*FNA
DATE ANALYZED 09*MAR*81
SAMPLE HANDLING 4120
HETUGE SAMPLED GRAD SUSTAINED YIELD YIELD HEAS HETHOD TOTAL REPTH OF WELL SWL AROVE(-) OR RELOW GS CASING DIAMETER CASING TYPE METHOD SAMPLED GRAD PERFORATION INTERVAL WATER USE UNUSED SAMPLING SITE SAND COULFE MINING DISTRICT*NO NAME CREEK GEOLOGIC SOURCE MORRISON FORMATION MG/L HEQ/L MG/1. MERZL 190. 7.48 BICARBONATE 9.71 CARBONATE (HCG3) (CG3) CALCIUM (CA) HAGNESIUM (MG) 118. 15.9 2.5 SODIUM (NA) 0.69 CHLORIDE (CL) 0.07 502. 2.54 (K) 5400. POTASSIUM SULFATE (304) 112.43 26.97 < .01 IRON (FE) NITRATE (AS N) HANGANESE (MN) 0.09 FLUORIDE (F) 3.97 0.26 SILICA (SID2) PHOSPHATE TOT (AS P) 104.0 TOTAL CATIONS 46.94 TOTAL ANIONS 112.76 STANBARD DEVIATION OF ANION-CATION BALANCE (SIGMA) LABORATORY PH 2.49 TOTAL HARDNESS AS CACOS 760.12 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT 9.6 C TOTAL ALKALINITY AS CACO3
SODIUM ADSORPTION RATIO
RYZNAR STABILITY INDEX
5292. LANGLIER SATURATION INDEX 0.22 LAB SPEC.COND. (MICROMHOS/CM) PARAMETER VALUE PARAMETER VAL UE CNDUCTVY, FIELD MICROHHOS ALUMINUM, DISS (MG/L-AL) SILVER, DISS (MG/L AS AG) BORON DISS (MG/L AS B) CADMIUM, DISS (MG/L AS CD) 5389. TCHPERATURE, AIR (C) 14.0 C EIELD PH 2.46 481. NICKEL,DISS (MG/L AS NI) LEAD,DISS (MG/L AS PR) STRONTIUM,DISS (MG/L SR) TITANIUM DIS(MG/L AS TI) 4.6 ..002 RORON DISS (HGZE AS B) CADMIUM, DISS (HGZE AS CD) CHROMIUM, DISS (HGZE-CR) <.04 .19 .74 .11 .069 COPPERIDISS (HG/L AS CU) LITHIUM; BISS(HG/L AS LI) MOLYBUENUM; DISS(MG/L -MO) MERCURY; DISS(UG/L AS HG) ACIDITY; TOT(MG/L-CACO3) VANADIUM, DISS (MG/L AS V) . 15 ZINC, DISS (MGZL AS ZN)
ZIRCONIUM DISCMGZL AS ZR
ARSENIC, DISS(UGZL AS AS)
SELENIUM, DISS (UGZL -SE) 19.5 .63 .038 <.1 <.03 1.4

REHARKS: WATER IS PALE YELLOW - BECOMES GRANGE UPON REACHING CREEK *
SPRING DRAINAGE FROM MINE ADIT AS-02 * JUST ABOVE LANDFILL - SAND
COULEE * DISCHARGE FROM ADIT (CAVED) AND OLD WOOD DRAIN PIPE *
LAB: HF=46.6 MGZL * 46.2 MERVSZL, SIGMA .97, 111.0 TOTAL CATION MERVSZL *

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L HILLIEGUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MFASURFD; (E) = ESTIMATED; (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

NA S 2 U1 CH PW OTHER AT

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: LAST ERIT RATE: 04-MAY-81 COST: BY: TP *CLG PROCESSING PROGRAM: F1730F V2 (11/3/81) 27-MAY-83 PRINCED:

> PERCENT MED/L (FOR PIPER PLOT) CA CL SD4 HCO3 0.1 99.7 0.0 SD4 HC03 0.0 NA K HG 48.8 3.5 0.0

WATER QUALITY ANALYSIS LAR NO. 8002318

```
COUNTY CASCADE
   STATE
LATITUDE-LONGITUDE
                                       MONTANA
                                       UTH COURDINATES
TOPOGRAPHIC MAP
         GEOLOGIC SOURCE
DRATHAGE BASIN
             RATHAGE BASIN
NEY I SAMPLER
BOTHE NUMBER
BAIC SAMPLED
TIME SAMPLED
                                                                                       SUSTAINED YIELD
                                        MRHG*JJD
        ASENEY
                                                                     YIELD MEAS METHOD
TOTAL DEPTH OF WELL
SWL ABOVE(-) OR BELOW GS
CASING DIAMETER
CASING TYPE
COMPLETION TYPE
                                        AS-03
70-SEP-B0
10:00 HOURS
         LAR + ANALYST
DATE ANALYZED
SAMPLE HANDLING
                                        HBMG*FNA
                                        09-MAR-81
                                        4120
           METHOD SAMPLED
                                       GRAB
                                                                             PERFORATION INTERVAL
                     WATER USE
                                        UNUSED
         SAMPLING SITE SAND COULEE HINING DISTRICT*NO-NAME CREEK GEOLOGIC SOURCE HORRISON FORMATION
                                                            MER/L
                                                                                                                       MGZI...
                                                                                                                                      MEGZIL
                                          MGZL
                                          426.
186.
20.2
<.15
                                                                                                    (HC03)
       CALCIUM (CA)
MAGNESIUM (MG)
                                                             21.26
                                                                         BICARBONATE
                                                                         CARBONATE
                                                                                                      (003)
                                                                                                                                       0.14
135.75
0.00
                                                                                                                           5.8
                                                                                                        (CL)
        SOLIUM
                           (NA)
                                                               0.38
                                                                         CHUCRIDE
                                                                                                                     6520.04
                                                                                                    (SO4)
(AS N)
                                                                          SULFATE
        POTASSIUM
                            (K)
                                          674.
                                                              36.21 NITRATE
0.35 FLUORIDE
        IRON
                           (FE)
                                                                                                                            5.7
        HANGANESE (MN)
                                                                                                          (F)
                                                                                                                                          0.35
        SILICA (SIG2)
                                          117.0
                                                                         PHOSPHATE TOT (AS P)
                                                                                         TOTAL ANIONS
                                                                                                                                       136,27
                                                              74.00
           TOTAL CATIONS
           STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                (SISHA)
                               LABORATORY PH
                                                                2:65
                                                                                 TOTAL HARDNESS AS CACOS
                                                                                                                                 1829,30
                                                               13.8 C TOTAL ALKALINITY AS CACOS
SODIUM ADSORPTION RATIO
RYZNAR STABILITY INDEX
26. LANGLIER SATURATION INDEX
   FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUB-OF-DISS. CONSTITUENT
                                                                                                                                       0.21
  LAB SPEC.COND. (MICROMHOS/CM)
                                                         5726.
                                                        VALUE
                                                                          PARAMETER
CNDUCTVY,FIELD NICROMHOS
ALUMINUM, BISS (MS/L-AL)
SILVER,DISS (MG/L AS AG)
BORON ,DISS (MG/L AS B)
CADMIUM,DISS (MG/L AS CD)
CHRGMIUM, DISS (MG/L AS CD)
CHRGMIUM,DISS (MG/L AS CU)
LITHIUM,DISS (MG/L AS CU)
LITHIUM,DISS (MG/L AS LI)
MOLYBDENUM,DISS (MG/L AG)
ACIDITY,TOT (MG/L -CACG3)
                                                                                        PARAMETER
                                                                                                                                   VALUE
             PARAMETER
TEMPERATURE, AIR (C)
                                                                                                                                 5414.
                                                        14,0 €
                                                        2.631
5.04
1.25
                                                                                                                                 552.
FIELD PH
FIELD PH
NICKEL,DISS (MG/L AS NI)
LEAB,DISS (MG/L AS PR)
STRONTIUM,DISS (MG/L AS T)
TITANIUM DISS(MG/L AS T)
VANADIUM,DISS(MG/L AS T)
ZINC,DISS (MG/L AS ZN)
ZIRCONIUM DISS(MG/L AS ZR
ARSENIC,DISS(US/L AS AS)
SELENIUM, DISS (UG/L-SE)
                                                                                                                                      006
                                                            .06
                                                                                                                                     .70
<.02
<.03
                                                        21.1
                                                          <.1
```

REMARKS: WATER IS PALE GRANGE - RECOMES BRIGHT RED UPON REACHING CREEK * SPRING AS-03 - FLOWING THRU SAND COULEE LANDFILL *

SAMPLE TAKEN JUST BELOW LANDFILL *
HE=36.7 Mg/L * 36.4 MERV/L, SIGMA .65 * 130 TOTAL CATION MERVS/L *

EXPLANATION: MG/L = MILLIGRANS PER LITER, UG/L = MICROGRAMS PER LITER, MCG/L MILLIEQUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

52 PR DIBLE LI 1 $\cap W$ AT UW MA

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: BY: PROJECT: LAST EDIT DATE: 04-MAY-81 DESSING PROGRAM: F1730P V2 (11/3/81) TP *CLC 27-MAY-83 PRINTERS PROCESSING PROGRAM:

> PERCENT MED/L (FOR PIPER PLOT)
> CA MG NA K CL 504 HC03
> C8 40.9 2.3 0.0 0.1 77.7 0.0 CA 003 2.3 56.8 40.9 0.0

```
COUNTY CASCADE
LATITUDE LONGITUDE 47D03'14'N 111D10'37'W SITE LOCATION 19N 4F 03 ADAC
UTH COORDINATES 712 N5247790 E486620 HBHG SITE AS 03
TOPOGRAPHIC MAP COUTHEAST GREAT FALLS 7 1 STATION ID 472314111103701
GEOLOGIC SOURGE 221HRSN* * SAMPLE SOURCE HINE DRAINAGE
DRAINAGE BASIN AB LAND SURFACE ALTITUDE 3570, FT 1 50
AGENCY + SAMPLER MEMS*JJD SUCTAINED YIELD
BOTTLE NUMBER AS 03 YIELD HEAS METHOD
                 ROTTLE NUMBER AS-03 YIELD HEAS HETROD
DATE SAMPLED 03-HAR-81 TOTAL DEPTH OF WELL
TIME SAMPLED 11:00 ROURS SWL AROVE(-) OR RELOW SS
LAR + ANALYST MRMG*FNA CASING DIAMFTER
DATE ANALYZED 22-APR-81 CAGING TYPE
HANDLING 4120 COMPLETION TYPE
           LAR + ANALYST
DATE ANALYZER
SAMPLE HANDLING
HETHOD SAMPLER
                                                                                      CAGING TYPE
CAGING TYPE
COMPLETION TYPE
PERFORATION INTERVAL
                                             27- APR-31
4120
GRAB
                      WATER USE
                                             UNUSED
               SAMPLING SITE STOCKETT " SAND COULEE HINING DISTRICT
           GEOLOGIC SOURCE MORRISON FORMATION
                                               MG/L
                                                                  HER/L
                                                                                                                                    HG/I
                                                                                                                                                    HER/L
                                               272.
                                                                    14.57 BICARBONATE
                                                                                                                (RC03)
        CALCIUM
                              (CA)
                                              190.
                                                                    15.63 CARBONATE
0.74 CHLORIDE
0.03 SULFATE
                                                                                                                (CD3)
         HAGNESIUH (MG)
                                                                                                                                    7700.
         SOBIUM
                              (NA)
                                                                                                                                                          0.06
         POTASSIUM (K)
                                                                                                                  (504)
                                                                                                                                                       160.31
        IRON (FE)
MANGANESE (MN)
SILICA (SIO2)
                                                               50.71 NITRATE
0.10 FLUCRIBE
                                                                                                                                                        0.12
                                                944.
                                                                                                                 (AS N)
                                                2.84
                                                                                                                      (F)
                                                                                                                                        12.8
                                                                                  PHOSPHATE TOT (AS P)
                                                                     81.79
             TOTAL CATIONS
                                                                                                   TOTAL ANIONS
                                                                                                                                                       161.17
             STANDARD DEVIATION OF ANION-CATION BALANCE (SIGHA)
  LABORATORY PH

FIELD WATER TEMPERATURE
CALCULATED DISSOLVED SOLIDS
SUM OF DISS. CONSTITUENT
LAB SPEC.COND. (MICROMHOS/CM) 6710. LANGLIER SATURATION INDEX
                                                                                          TOTAL HARDNESS AS CACOS
                                                                                                                                               1511,16
                                                                                                                                                       0.17
                                                                                PARAMETER
CNDUCTVY, FIELD HICROMHOS
ALVMINUM, TR (MC/
                                                                                                                                                  VALUE
               PARAMETER
                                                              VALUE
TEMPERATURE, AIR (C)
                                                          10. C
3.38
<2.1
.8
579. 02
.22
.0279
.252
.144
.651
.83
                                                              10.
                                                                                                                                                 8510.
                                                                                   ALUMINUH, TR (HG/L AS AL)
IRON, TR (HG/L AS FE)
ACIDITY, TOT (HG/L AS RE)
NICKEL, DISS (HG/L AS RE)
LEAD, DISS (HG/L AS PR)
                                                                                                                                               752.
1210.
FIELD PH
ARSENIC, TR (UG/L AS AS)
SCIFNIUM, TR (UG/L AS SE)
ALUMINUM, DISS (HG/L AL)
SILVER, DISS (HG/L AS AG)
DORON, DISS (HG/L AS B)
CADMIUM, DISS (HG/L AS CD)
                                                                                                                                              5002.
                                                                                                                                                    <.04
                                                                                    STRONTIUM, DISS (MG/L-SR)
TITANIUM DIS(MG/L AS TI)
                                                                                                                                                    1.13
                                                                                                                                                    .003
CHROMIUM, DISS (MS/L-CR)
COPPER,DISS (MG/L AS CU)
LITHIUM,DISS(MG/L AS LI)
                                                                                    VANADIUH, BISS (HGZL AS V)
VINC, DISS (HGZL AS ZN)
ZIRCONIUM BIS (HGZL AS ZR
ARSENIC, DISS (UGZL AS AS)
                                                                                                                                                   21.5
                                                                                                                                                      .061
HOLYSDENUH, DISS (HG/L-MO)
                                                                  · B3
```

REMARKS: WATER TURBID-FILTERS CLEAR*ORGANIC MATTER: AL-HYDROXIDE IN FILTERATE : SAMPLE TAKEN AT ADIT HOUTH - ABOVE SAND COULEE LANDFILL * LAB: 150.0 TOTAL CATION MEGVS, 2.95 SIGMA, EST H+ 48 MG/L *

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEG/L = MILLIFQUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

QW WA 52 WI OW Fill AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

SELENIUM, DISS (UG/L-SE)

COST: LAST EDIT DATE: 27-AFR 81 TP *CLG PROCESSING PROGRAM: 27 - MAY 83 F1730P V2 (11/3/81) PRINTED:

> PERCENT HEGAL (FOR PIPER PLOT) CA MB NA K CL 504 HCD3 CO3 CA MS 2.1 47.0 50.5 0,1 0.0100.0 0.0 0.0

WATER QUALITY ANALYSIS LAB NO. BOR2319

STAFE MONTANA

LATITUDE-LONGITUDE 47D23'34'N 111D10'46'N SITE LOCATION 19N 4E 14 DDCD

UTH COORDINATES 212 N5248670 E486570 MRMG SITE AS-04

TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1 STATION ID 472334111104601

GEOLOGIC SOURCE 221MRSN* * SAMPLE SOURCE MINE DRAINAGE

DRAINAGE BASIN 88 LAND SURFACE ALTITUDE 3540; FT < 50 COUNTY CASCADE STAFE MONTANA AGENCY & SAMPLER BOTTLE NUMBER SUSTAINED YIELD **GLU*9H8H** AS-04
20-SEP-80
12:00 HOURS
SWL AROVE(-) OR RELOW GS
MRMG*FNA

SUL AROVE(-) OR DIAMETER NUMBER BATE SAMPLED TIME SAMPLED CASING DIAMETER CASING TYPE COMPLETION TYPE PERFORATION INTERVAL LAR + ANALYST DATE ANALYZED SAMPLE HANDLING METHOD SAMPLED MSMG*FNA 09"MAR"B1 4120 6RAB WATER USE UNUSED SAMPLING SITE SAND COULEE MINING DISTRICT*NO-NAME CREEK GEOLOGIC SOURCE MORRISON FORMATION 8.53 BICARBONATE MG/L HEQ/L MG/I.. MERZI 171. 133. 23.5 (HC03) CALCIUM (CA) MAGNESIUM (MG) (003) 4.5 1.02 CHLORIDE (CLD) 0.14 SODIUM (NA) SULFATE (K) 436. 0.11 3560. 74.12 (804) COTASSIUM <.02 NITRATE (AS N) IRON 1.63 MANGANESE (MN) 0.06 FLUDRIDE (7) 3.31 0.17 SULICA (SIO2) PHOSPHATE TOT (AS P) 74.43 TOTAL CATIONS 44.09 TOTAL ANIONS STANDARD DEVIATION OF ANION-CATION BALANCE (SISMA) 3.04 TOTAL HARDNESS AS CACO3 12.0 C TOTAL ALKALINITY AS CACO3 SODIUM ADSORPTION RATIO RYZNAR STABILITY INDEX 638. LANGLIER SATURATION INDEX LABORATORY PH 574.42 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT LAB SPEC.COND. (MICROMHOS/CM) 0.33 3638. PARAMETER CNDUCTVY/FIELD MICROMHOS VALUE PARAMETER TEMPERATURE, AIR (C) VALUE 14. C 3.84 2.10 <..04 3329. CNDUCTVY, FIELD MICROMHOS ALUMINUM; DISS (MG/L-AL) SILVER, DISS (MG/L AS AG) BORON; DISS (MG/L AS B) CARMIUM; DISS (MG/L AS CD) CHROMIUM; DISS (MG/L AS CU) COPPER, DISS (MG/L AS CU) LITHIUM; DISS (MG/L AS LI) MOLYBDENUM; DISS (MG/L AS LI) MERCURY; DISS (UG/L AS HG) ACIDITY; TOT (MG/L-CACO3) 243. FIELD PH FIELD PH
NICKEL, DISS (MG/L AS NI)
LEAD, DISS (MG/L AS PB)
STRONTIUM, DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS ZN)
ZIRCONIUM DIS (MG/L AS ZR
ARSENIC, DISG (UG/L AS AS)
SELENIUM, DISS (UG/L-SE) <.002 .027 .052 .064 3.34 .041 .57 .028 ,03 <.03 40.5 2077.

REMARKS: WATER IS TURBID - MILKY - BECOMES GRANGE UPON REACHING CREEK *
KATE'S COULEE AT MINE ADIT (SITE AS-04) * ABOVE DISON HOUSE *
SAMPLE TAKEN AT TOP POOL OUTSIDE ADIT - FLOW JUST BELOW *
LAD: Ht=9.1 MG/L, SIGMA 5.54, TOTAL CATION MERVS/L 52 *

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEG/L MILLIEGUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

RW WA S2 WI OW PW AT OTHER

OTHER AVAILABLE DATA OTHER FULE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 04-MAY-81 BY: TP *CLC
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT MEQ/L (FOR PIPER PLOT)
CA MD NA K CL S04 HC03 C03
41.4 53.1 5.0 0.5 0.2 99.8 0.0 0.0

```
STATE MONTANA

LATITUDE - LONGITUDE 47D23'34'N 111D10'43'N SITE LOCATION 19N 4E 14 DDCD

UTH COORDINATES 710 NS218300 E483505 HRMG SITE AS-04

TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1 STATION ID 472334111104301

SFOLOGIC SOURCE 721HRSN* * SAMPLE SOURCE MINE DRAINAGE

DRAINAGE RASIN BE LAND SURFACE ALTITUDE 3560. FT 1.50

AGENCY + SAMPLER HBHG*JUD SUSTAINED YIELD

DOTTLE NUMBER AS-04 YIELD HFAS HETHOD

DATE SAMPLED 03-MAR-81 TOTAL DEPTH OF WELL

TIME SAMPLED 00:30 HOURS SWI ABOVE(-) OR BELOW GS

LAR + ANALYST HBMG*FNA CASING DIAHTTER

DATE ANALYFD 22 APR-81 COMPLETION TYPE *

METHOD SAMPLED GRAB FERGRATION INTERVAL

WATER USE UNUSED
            BATE SAMPLED 03-MAR-81
TIME SAMPLED 00:30 HOURS
LAR + ANALYST MRMG*ENA
DATE ANALYFD 22 APR-81
SAMPLE HANDLING 4120
METHOD SAMPLED GRAD
WATER USE
                   SAMPLING SITE STOCKETT SAND COULEE HINING DISTRICT
              GEOLOGIC SOURCE MORRISON FORMATION
                                                           MG/L
                                                                                  HERYL
                                                                                                                                                                     HGZL HEQZL
                                                           167.
                                                                                    8.43 BICARBONATE
          CALCIUM
                                                                                                                                          (RC03)
                                     (CA)
           HAGNESIUM (MG)
                                                                                      11.35 CARRONATE
                                                                                                                                           (603)
                                                           4.7
4.6
1.57
51.2
                                                                                    0.78 CHLORIBE
           SODIUH
                                     (NA)
                                                                                                                                             (CL)
(SO4)
                                                                                                                                                                                                0.15
                                                                                                                                                                   3222.
.05
3.02
                                                                                      0.12 SULFATE
25.03 NITRATE
           POTASSIUM
                                      (K)
                                                                                                                                                                                              47.08
          IRON (FC)
HANGANESE (HN)
SILICA (SIO2)
                                                                                                                                                                                             0.16
                                                                                                                                            (AS N)
                                                                                     0.06 FLUORIDE
                                                                                                                                                  (F)
                                                                                                      PROSPHATE TOT (AS P)
                 TOTAL CATIONS
                                                                                      45.78
                                                                                                                          TOTAL ANIONS
                                                                                                                                                                                              67.45
                STANDARD BEVIATION OF ANION-CATION BALANCE
                                                                                                                                      (SIGMA)
                                                                                  3.00 TOTAL HARDNESS AS CACOS
11.0 C TOTAL ALKALINITY AS CACOS
SODIUM ADSORPTION RATIO
RYZNAR STABILITY INDEX
                                           LABORATORY PH
                                                                                                                                                                                    550.00
  FIELD WATER TEMPERATURE 11.0 C TOTAL ALKALINITY AS CACGI CALCULATED DISSOLVED SOLIDS SOLUM ADSCRPTION RATIO SUM OF DISS. CONSTITUENT RYTHAR STABILITY INDEX LAB SPEC.COND.(MICROHHOS/CM) 3573. LANGLIER SATURATION INDEX
                                                                                                                                                                                           0.31
                   PARAMETER
                                                                                                  CARAMETER
CARROCTVY, FIELD MICROMHOS
ALUMINUM, TR (MG/L AS AL)
ACIDITY, TOT (MG/L ACIDITY)
                                                                             VALUE
                                                                                                                                                                                     VALUE
                                                                             0. C
3.78
1.54
 TEMPERATURE, AIR (C)
                                                                                                                                                                                   4105.
                                                                                                                                                                            458.
2315.
                                                                                                                                                                                 456.
FIELD PH
IRON, TR (HG/L AS FE)
ARSENIC, TR (UG/L AS AS)
ALUHINUM, DISS (HG/L AL)
SILVER, DISS (HG/L AS AG)
BORON, DISS (HG/L AS B)
CADHIUM, DISS (HG/L AS CD)
CHROMIUM, DISS (HG/L AS CU)
LITHIUM, DISS (HG/L AS CU)
LITHIUM, DISS (HG/L AS LI)
HOLYBDENUM, DISS (HG/L +HO)
SELENIUM, DISS (UG/L +SE)
FIELD PH
                                                                               1.56
                                                                                                        ACIDITY, TOT (MG/L "CACO3)
                                                                                                       ACIDITY, TOT (MG/L -CACO3)
SELENIUH, TR (UG/L AS SE)
NICKEL, DISS (HG/L AS NI)
LEAD, DISS (HG/L AS PB)
STRONTIUM, DISS (HG/L AS TI)
TITANIUM DIS(HG/L AS TI)
VANADIUM, DISS (HG/L AS TN)
ZIRCONIUM DIS(HG/L AS ZR
ARSENIC, DISS(UG/L AS AS)
                                                                           41.1
                                                                                                                                                                                        2.12
                                                                          .023
.24
.027
.067
                                                                                                                                                                                       1.15
                                                                                  .026
                                                                                                                                                                                           .050
```

REHARKS: SAMPLE CLEAR - LITTLE FILTERATE *
SAMPLE TAKEN AT HINE ABIT ABOVE J. OLSON HOME *
COLD WATER UPSTREAM S.C.=1266 BOWNSTREAM 3818 *
LAB: 67.1 CATION MERVS..15 SIGMA, 32.9 MG/L EST HE *

. 4

HGZL = HILLIGRAMS PER LITER, UGZL = HICROGRAMS PER LITER, HEGZL HILLIEGUIVELENTS PER LITER. FT = FEET, HI = HETERS. (M) = HEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

> QW WA 5.2 WI CW FILL AT OTHER

OTHER AVAILABLE BATA OTHER FILE NUMBERS:

COST: PROJECT: TP #CLG 27 HAY 83 LAST EDIT DATE: 07-APR-81 PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTER:

> PERCENT MER/L (FOR PIPER PLOT) CA HG 40.4 54.3 4.7 CL 804 HC03 C03 HG K 0.3

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8100050

37.0

```
MONTANA
                                                                                                          CASCADE
                                   47023'34'N 111010'46'W SITE LOCATION 12N 04E 14 DBCD 712 N5248670 E486570 HBMG SITE AS04 SOUTHEAST GREAT FALLS 7 1 STATION ID 472334111104601 221HRSN* * SAMPLE SOURCE MINE DRAINAGE
 LATITUDE-LONGITUDE
                                                                   ### SAME LOCATION 19N 04E 14 BBCD HBMG SITE AS04

ALLS 7 1 STATION ID 472334111104601

* SAMPLE SOURCE MINE DRAINAGE
LAND SURFACE ALTITUDE 3540; FT < 50
SUSTAINED YIELD
     UTH COORDINATES
TOPOGRAPHIC MAP
GEOLOGIC SOURCE
DRAINAGE BASIN
AGENCY + SAMPLER
          NCY + SAMPLER
BOTTLE NUMBER
                                   BB
                                   HEHG*ABH
                                                                           YIELD HEAS HETHOD
                                   AS04
            DATE SAMPLED 15-JUL-81
TIME SAMPLED 14:00 HOURS
                                                              TOTAL BEFTH OF WELL
SWL ABOVE(-) OR BELOW GO
CASING DIAMETER
      LAB + ANALYST MEMO*
DATE ANALYTED
SAMPLE HANDLING 4220
HETHOD SAMPLED GRAB
                                   HEHG*FNA
                                                                              CASING TYPE
                                                                     PERFORATION INTERVAL
                 WATER USE UNUSED
      SAMPLING SITE SAND COULER HINING DISTRICT*NO-NAME CREEK GEOLOGIC SOURCE HORRISON FORMATION
                                                     HER/L
                                                                                                             MG/L
                                                                                                                         MEQ/L
                                     HG/L
                                                        8.03 BICARBONATE
9.71 CARBONATE
0.77 CHLORIBE
0.04 SULFATE
                                                                                          (RC03)
                      (CA)
                                                                                                                .0
                                     151.
     CALCIUM
                                     118.
     MAGNESIUM (MG)
                                                                                                                  . 0
                                                                                                                            0.26
60.75
0.02
0.19
                                                                                                                7.1
                                                                                              (CLD)
     SORTUN
                      (NA)
                                                                                                           2918.1
.32
                      (K)
                                                                                             (SO4)
     POTASSIUM
                                     568.
2.00
62.1
     IRGN
                                                       30.51
                                                                  NITRATE
                                                                                           (AS N)
     MANGANESE (HN)
                                                        0.07 FLUDRIDE
                                                                                               (F)
                                                                                                                3.57
     SILICA (SIG2)
                                                                 PHOSPHATE TOT (AS P)
        TOTAL CATIONS
                                                       49.14
                                                                                TOTAL ANIONS
                                                                                                                            61.22
        STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                      (SIGMA)
                          LABORATORY PH
                                                         3.63
                                                                         TOTAL HARDNESS AS CACOS
                                                                                                                      887.71
 FIELD WATER TEMPERATURE
CALCULATED DISSOLVED SOLIDS
SUM OF DISS. CONSTITUENT
                                                                   TOTAL ALKALINITY AS CACGI
SODIUM ADSORPTION RATIO
RYZNAR STABILITY INDEX
LANGLIER SATURATION INDEX
                                                        13.7
                                                                                                                          0.26
LAB SPEC.COND. (HICROHHOS/CH) 3337.
                                                 VALUE
                                                                                PARAMETER
                                                                                                                      VALUE
          PARAMETER
                                                 22. C
3.85
3.27
<.04
                                                                                                                      3284.
                                                                                                                      346.
                                                                                                                        <.002
```

PARAMETER
CHDUCTVY+FIELD HICROMHOS
ALUMINUM+ DISS (MG/L-AL)
SILVER+DISS (MG/L AS AG)
BORON +DISS (MG/L AS B)
CADMIUM+DISS (MG/L AS CD)
CHROMIUM+ DISS (MG/L-CR)
COPPER+DISS (MG/L AS CU)
LITHIUM+DISS (MG/L AS LI)
HOLYBDENUM+DISS (MG/L-HG) TEMPERATURE, AIR (C) TEMPERATURE, AIR (C)
FIELD PH
NICKEL, DISS (MG/L AS NI)
LEAD, DISS (MG/L AS PB)
STRONTIUM, DISS (MG/L AS TI)
TITANIUM DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS TI)
ZINC, DISS (MG/L AS ZN)
ZIRCONIUM DIS (MG/L AS ZR
IRON, TR (MG/L AS FE)
ALUMINUM, TR (MG/L AS AL) .25 .074 .17 .030 <.02 13.6 577. HÔL YÊĐENŰH, DISS(HGZL-HÔ) SELENIUH, TR (UGZL AS SE) ACIDITY, TOT (HGZL-CACO3) 1.8 348. 1970.

REMARKS: WATER CLEAR BUT GASSY UPON FILTRATION

KATE'S COULEE AT HINE ABIT * SITE AS-04 * ABOVE OLSO SAMPLE FROM ADIT MOUTH LAB: H+ 39.43 MG/L GIVES 57.9 MER CATIONS GIVES 3:3 SIGMA ADIT * SITE AS-04 * ABOVE OLSON HOUSE *

MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/ HILLIEQUIVELENTS PER LITER, FT = FEET, HT = HETERS, (H) = HEASURED, (E) = ESTIMATED, (R) = REPORTED, TR = TOTAL RECOVERABLE, TOT = TOTAL

U.U. 52 WI OW FW AT BILLES WA

OTHER AVAILABLE DATA OTHER FILE NUMBERS: 8002319 8100058

PROJECT: COST: LAST EDIT DATE: 19-FEB-82 BY: PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: TP *JKS 27-HAY-83

> PERCENT MEDZL (FOR PIPER PLOT) NA 4.2 CA MG 43.3 52.3 0.2 0.4 55.6 0.0 003

LAR NO. BORRESCO

STATE HONTANA COUNTY CASSAGE LATTIUDE - LONGITUDE UTH COORDINATES TOPOGRAPHIC HAP TOPOGRAPHIC HAP
SEDLOGIC SOURCE
DRAINAGE BASIN
AGENCY + SAMPLER
DOTTLE NUMBER
DATE SAMPLED
TIME SAMPLED
LAR + ANALYSE
DATE ANALYSE
SAMPLE HANDLING
HETHOD SAMPLED 1.0 GTAFF GAGE STREAM STAGE DEPTH TO SAMPLE DEPTH OF WATER 12:00 HOURS HBMG*FNA 18-FF):-81 TOTAL STREAM WINTH

WATER USE UNUSED

METHOD SAMPLED GRAD

SAMPLING SITE SAND COULER MINING DISTRICT*NO NAME CREEK DRAINAGE BASIN MISSOURI RIVER BETWEEN HARIAS RIVER AND LITTLE PRICKLY PE

CALCIUM (CA) HAGNESTUM (MG) CODIUM (NA)	MG/L 167. 141. 23.2	11.60	BICARBONATU CARBONATE	(RC03)	HG/L	MEG/L
SOPIUM (NA) PGTASSIUM (N) IRON (FE) HANGANESE (MN) GILICA (SIO2)	1.6 380. 1.63	20.41	CHLORIDE SULFATE HITRATE FLUORIDE PROSPRATE TOE	(CL) (SD4) (AS N) (E) (AS E)	3150. .03 3.25	0.17 65.58 0.17
TOTAL CATIONS		41.66		ANIONS		65.72

STANDARD DEVIATION OF ANION-CATION BALANCE (SIGHA)

LABORATORY PH 2.87 TOTAL HARDNESS AS CACO3 14.1 C FOTAL ALKALINITY AS CACO3 SORTUM ARSORPTION RATIO RYZNAR STABILITY INDEX 1002:35 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT 0.33 LAS SPEC.COND. (HICROHHOS/CM) LANGLIER SATURATION INDEX 3536.

PARAMETER	VALUE	PARAHETER	VALUE
TEMPERATURE, ATR (C)	15.0 C	ENDUCTVY/FIELD HICRORHOS	3352.
FIFED PH	3,42	ALUMINUM, DISC (MG/L AL)	242.
NICKEL, DISS (HG/L AS NI)	2.08	SILVER, DISS (NG/L AS AS)	-,002
LEAD, DISS (MS/L AS PR)	< . 0.4	BORGN DRISS (MS/L AS B)	.16
STRONTTUH/DISS (HG/L-SR)	1.08	CADMIUN/DISS(MG/L AS CD)	.033
TITANTUM BIS(MG/L AS TI)	.047	CHRCHIUM, DISS (HG/L-CR)	.040
VANADIUH, DISS(HS/L AS V)	.034	COMMERADIOS (MOZE AS OU)	.016
ZINC:DISS (MG/L AS ZN)	0.36	LITHIUH, DISS(MG/L AS LI)	.55
ZIRCONIUM DISCHG/L AS ZR	.025	HOLYBRENUH/RISS(MG/L HO)	1.02
ARSENIC: BISS(US/L AS AS)	7.5	MERCURY-BISS(UG/L AS HS)	,23
SELENIUM, DISS (UG/L-SE)	<.3	ACIDITY, TOT (MG/L -CACG3)	2262.

REHARKS: WATER IS BRIGHT GRANGE - BECOMES BEEF REB UPON REACHING CREEK * SAMPLE TAKEN AT CONFLUENCE OF KATE'S CREEK WITH NO-NAME CREEK FROM NATE'S CREEK * OWNER REPORTS RAIN CAUSES WHITE PRECIPITATE * LAB: HF=15.9 HGZL * 15.8 HERVSZL, SIGHA +.46, 66.4 TOTAL CATION MEGVSZL *

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, HEG/L : MILLIFOUTVELENTS PER LITER. FT = FEFT, HI = METERS. (M) = MEASURED, (E) = ESTIMATER, (R) = REPORTED. IR = TOTAL RECOVERABLE. TOT = TOTAL.

> WA SE QW UT n W PN AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECTI IF *CLC 27 MAY 83 PROCESSING PROGRAM: 04 MAY 81 RY: F1730F V2 (11/3/01) PRINTED: RY:

> PERCENT HEGYL (FOR PIPER PLOT) NA 1 CL SC4 HCD3 CD3 0.3 99.7 0.0 0.0 CA HG 37.8 54.7 0.5 4.7

WATER QUALITY ANALYSIC LAB NO. 8100057

HONTANA COUNTY CASCADE LATITUDE-LONGITUDE AS-05 47233311110380; HRHG SITE STATION ID SAMPLE SOURCE UTH COORDINATE TUPOGRAPHIC HA HAF GEOLOGIC SUURCE *

DRAINAGE BASIN BB

AGENCY + SAMPLER HBMG*JUD

DOTTLE NUMBER AS*05

DATE SAMPLED 03*HAR*81

TIME SAMPLED 09:00 HOURS PLE SOURCE E ALTITUDE FLOW RATE * STREAM * 3510. LAND SURFACE FI WATER GPH FLOW HEAS HETHOD ESTIMATED STAFF GAGE STREAM STAGE LAR F ANALYST MANG*ENA DATE ANALYZED 22-AFR-81 SAMPLE HANDLING 4120 DEPTH TO SAMPLE TOTAL DEPTH OF WATER STREAM WIDTH HETHOD SAMPLED GRAD

WATER USE UNUSED

SAMPLING SITE STOCKETT " SAMD COULEE MINING DISTRICT DRAINAGE BASIN MISSOURI RIVER BETWEEN MARIAS RIVER AND LITTLE PRICKLY

CALCIUM (CA)	MG/L 99.0		BICARSONATE	(HC03)	HOZI	HER/L
MAGNESIUM (MG) SODIUM (NA) POTASSIUM (K) IRON (FE) MANGANESE (MN) SILICA (SIO2)	79.4 12.8 3.4 136. .58 30.6	0.53 0.05 9,75	CARBONATE CHLORIDE SULFATE NITRATE FLUORIDE PHOSPHATE TOT	(003) (0L) (004) (AS N) (F) (AS P)	5.4 2854. .09 2.63	0.18 57.42 0.01 0.14
TOTAL CATIONS		22.14	TOTAL	ANIONS		59.75

STANDARD DEVIATION OF ANIGH-CATION BALANCE (SIGMA)

LABORATORY PH 2.89 TOTAL HARDNESS AS CACO3 574.01
FIELD NATER TEMPERATURE 46,2 C TOTAL ALKALINITY AS CACO3
CALCULATED DISSOLVED SOLIDS SOBJUM ADSORPTION RATIO 0.23
SUH OF DISS. CONSTITUENT RYZNAR STABILITY INDEX
LAB SPEC.COND.(HICROMHOS/CM) 3319. LANGLIER SATURATION INDEX

PARAMETER	VALUE	PARAHETER	VALUE
TEMPERATURE, AIR (C)	8. C	CNBUCTVY, FIELD MICROMHOS	3426.
FIELD PH	3.39	ALUHINUH, TR (MB/L AS AL)	127.
IRON, TR (HO/L AS FE)	192.	ACIDITY, TOT (MO/L-CACOS)	2270.
ARSENIC, TR (UG/L AS AS)	14.4	SELENIUM, TR (UGZL AS SE)	• 4
ALUKINUH, DISS (MG/L-AL)	124.	NICKEL/DISS (MG/L AS NI)	1.22
SILVER: DISS (MG/L AS AG)	.06	LEAG-DISS (MG/L AS PR)	, 13
BORON FRISS (MG/L AS B)	.17	STRONTIUM,DISS (MS/L-SR)	, 624
CADMIUM-BISS(MG/L AS CB)	.034	TITANIUM BIS(MG/L AS TI)	.025
CHROMIUM, DISS (MG/L-CR)	.063	VANABIUM, DISS(MS/L AS V)	.071
COPPER:DISS (MG/L AS CU)	.050	ZINC, DISS (MG/L AS ZN)	4,47
LITHIUM, DISS(MG/L AS LI)	.305	ZIRCONIUM DISCHGZL AS ZR	, 085
MOLYBRENUM, RISS(MG/L-MG)	.57	ARSENIC+BISS(UG/L AS AS)	14.4
SELENIUM. DISS (UG/L SE)	. 3		

REMARKS: WATER IS GRANGE - TURBID * FE-HYDROXIDE PRECIPITATE *
SAMPLE FROM BELOW CULVERT ABOVE JUNCTION WITH STRAIGHT CREEK *
STREAM DRAINAGE FROM ACID SPRING AS-04 * UPSTREAM S.C. 5192 DOWN 417
LAB: 57.9 CATION MERVS, 195 SIGMA, 42.6 MG/L EST HE *

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, HEQ/L MILLIEQUIVELENTS PER LITER. FT = FEET, HT = METERS. (H) = MEASURED; (E) = ESTIMATED: (R) = REPORTED: TR = TOTAL RECOVERABLE: TOT = TOTAL.

RW WA S2 WI OW PW AT STHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST: COST: LAST FICE DATE: 29-APR 01 BY: TF *CLG
PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTED: 27-MAY 03

PERCENT MEQ/L (FOR PIPER PLOT)
CA MG NA K CL 804 HC03 C03
40.8 53.9 4.6 0.7 0.3 99.7 0.0 0.0

LAB NO. 8002371

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STATE MONIANA

COUNTY CASCADE

LATITUDE - LONGITUDE 47023/59*N 111010/10*W SITE LOCATION 19N 1E 13 CASD

UTH COURDINATES 712 N5249350 E487195 MRNG SITE AS 04

TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1 STATION IN 472359111101001

GEOLOGIC SOURCE 221MRSN*111SPRK* * SAMPLE SOURCE MINE DRAINAGE

DRAINAGE BASIN BB LAND SURFACE ALTITUDE 3500. FT 50

AGENCY + SAMPLER MRNG*JUD SUSTAINED YILLD

DOTLE NUMBER AS 04
         DRAINAGE BASIN BE

AGENCY + SAMPLER MEMSI

DOTILE NUMBER AS 06

DATE SAMPLED 16:00

LAB + ANALYST MEMGI

DATE ANALYZED 18:FF

GAMPLE HANDLING 41:20

METHOD SAMPLED GRAD
                                                                                                                                                          YIELD MEAS HETHOR
TOTAL REPTH OF WILL
SWL AROVE() OR RELOW GS
CASING RIAHCTER
CASING TYPE
COMPLETION TYPE
PERFORATION INTERVAL
                                                                                      AS- 06
20 SEP-30
16:00 HOURS
                                                                                      nEMG*FNA
                                                                                      18- FEB-81
                                                                                                                                                                                                                                                                                      t
                                        WATER USE
                                                                                     UNUSER
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SAMPLING SITE SAND COULEE MINING DISTRICT*NO NAME CREEK. SCOLOGIC SOURCE MORRISON FORMATION

CALCIUM (CA) MAGNESIUM (MG) CODIUM (NA) POTASSIUM (K) IRON (FE) MANDANESE (MN) SILICA (SIO2)	MG/L 62.0 88.0 18.2 2.4 74.1 1.07 50.5	7.31 0.79 0.00 3.28	RICARBONATE CARBONATE CHECRIDE SULFATE HITRATE FLUORIDE PHOSPHATE TOT	(AS N)	1030. 1030. 2.40	0.21 22.07 0.00 0.13
TOTAL CATIONS		15.27	TOTAL	SHOINS		22.31

STANBARD BEVIATION OF ANION-CATION BALANCE (SIGNA)

LARORATORY PH	2.57	TOTAL HARDNESS AS	DACG3 520.3	4
FIELD WATER TOMPERATURE	10.4 C	TOTAL ALKALINITY AS	CACOZ	
CALCULATED DISSOLVED SOLIDS		SODIUM ADSORFTION	RATID 0.3	S
SUM OF DISS. CONSTITUENT		RYTNAR STABILITY	IHDEX	
LAR SECC.COND. (MICROMHOS/CH)	1808.	LANGLIER SATURATION	INDEX	

PARANETER	VALUE	PARAMETER	VALUE
TEMPERATURE, AIR (C)	13.0 C	CNDUCTVY FIELD MICRORHOS	1701.
CIFLD OH	3.02	ALUMINUM, DISS (HGZL AL)	50.6
NICKEL PRISS (MG/L AS NI)	.42	SILVER/DISS (MG/L AS AG)	.002
LEAD DISS (NG/L AS PD)	04	BURON → DIGS (MS/L AS B)	, 17
STRONTIUM, DISS (MS/L SR)	.36_	CADMIUM,D(SS(MS/L AS CD)	.010
TITANIUM BIS(MG/L AS TI)	→ 013	CHRCHIUM, BISS (MG/L CR)	.011
VANADIUM, DISS (MG/L AS V)	.027	COPPER:DISS (MG/L AS CU)	.007
ZINCIBISS (MG/L AS ZN)	.87	LITHIUM, DISS(MS/L AS LI)	.35
ZIRCONIUM DISCHG/L AS ZR	<.004	MOLYEDENUM, ELSS (MG/L-MG)	<.02
ARSENIC, DISS(UG/L AS AS)	1.6 . ም	MERCURY, BISS(US/L AS HS)	1,23
SELENIUM · BISS (UG/L ·SE)	. 3	ACIDITY, TOT (MG/L ~CACO3)	561.

REMARKS: SAMPLE CLEAR " NO PRECIPITATE *

OPRING DISCHARGES FROM WITHIN SPOIL PILE IN FRONT OF ADIT *

ADIT APPEARS DRY * LAB: HF=5.0 MG/L * 4.9 MEGVS/L, SIGMA .09, 22.5 TOTAL CATION MEGVS/L *

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEG/L = MILLIEQUIVELENTS PER LITER, FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMALED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

22 MI OW PW AT GW IJ A OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: 04 MAY 91 RY: F1730F V2 (11/3/81) PRINTED: TP #CLC 27 MAY 83 LAST EDIT DATE: PROCESSING PROGRAM:

> PERCENT MEGAL (FOR PIPER PLOT) CI CA MG NA S04 HC03 003 7.0 0.5 1.0 77.0 0.0 27.5 34.9

STATE MONTANA

WATER QUALITY ANALYSIS

CASCADE

COUNTY

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TITUBE-LONGITUDE 47D23'46'N 111D10'20'N SITE LOCATION 19N 4E 13 CMDC UTH COORDINATES ZIZ N5249020 F486960 HBMG SITE AS-07 TOPOGRAPHIC HAP SOUTHEAST GREAT FALLS 7 1 STATION ID 472348111102001 GEOLOGIC SOURCE 221HRSN*L11SPBN* * SAMPLE SOURCE MINE DRAINAGE DRAINAGE BASIN BB LAND SURFACE ALTITUDE 3520. FT < 50 SGENCY + SAMPLER MBMG*JJD SUSTAINED YIELD
      LATITUDE-LONGITUDE
          GEOLOGIC SOURCE 221HRSN#11
DRAINAGE BASIN BB
AGENCY + SAMPLER MBHG*JJD
BOTILE NUMBER AS-07
            DOTTLE NUMBER AS-07
DATE SAMPLED 20-5EP-80
TIME SAMPLED 17:00 HOURS
LAB 4 ANALYST MBMG*FNA
DATE ANALYZED 18-FEB-81
SAMPLE HAMBLING 4120
METHOD SAMPLED GRAB
                                                                                         SUSTAINED YIELD
YIELD MEAS METHOD
TOTAL DEPTH OF WELL
SWL ABOVE(-) OR BELOW GS
CASING DIAMETER
CASING TYPE
COMPLETION TYPE
PERFORATION INTERVAL
                           WATER USE
                                                   UNUSED
            SAMPLING SITE SAND COULEE MINING DISTRICT*NO-NAME CREEK GEOLOGIC SOURCE HORRISON FORMATION
                                                      MG/I.
                                                                             HEQ/L
                                                                                                                                                           HGZL -
                                                                                                                                                                              ME RZIL
                                                      108.
                                                                                  7.38 BICARBONATE
                                                                                                                                  (R003)
          CALCIUN
                                   (CA)
                                                     180.
          MAGNESIUM (MG)
                                                                                14.81
                                                                                              CARBONATE
                                                                                0.79 CHLORIBE
0.02 SULFATE
53.93 NITRATE
                                                                                                                                                                               0,12
                                                                                                                                    (CL)
(S04)
           SODIUM
                                   (NA)
                                                                                                                                                                4,1
                                                                                                                                                        7940.
7.2
                                   (K)
(FE)
          POTASSIUM
                                                    1004.
           IRON
                                                                                                                                   (AS N)
          MANGANESE (MN)
                                                                                0.13 FLUORIDE
                                                                                                                                         (F)
                                                                                                                                                                                    0.38
                                                       128.0
          SILICA (SIGE)
                                                                                              PROSPRATE TOT (AS D)
               TOTAL CATIONS
                                                                                75,05
                                                                                                                  TOTAL ANIGNS
                                                                                                                                                                               145.61
               STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                                              (SIGMA)
                                                                                  2.55 TOTAL HARDNESS AS CACO3
11.7 C TOTAL ALKALINITY AS CACO3
CODIUM ADSORPTION RATIO
RYZNAR STABILITY INDEX
LANGLIER SATURATION INDEX
                                        LABORATORY PH
                                                                                                                                                                       1210:32
  FIELD WATER TEMPERATURE
CALCULATED DISSOLVED SOLIDS
SUM OF DISS. CONSTITUENT
LAB SPEC.COND.(MICROPHOS/CH)
                                                                                                                                                                               0.23
                                                                          6238.
PARAMETER TEMPERATURE, AIR (C)
                                                                         VALUE
                                                                                                                   PARAMETER
                                                                                                                                                                         VALUE
                                                                        13.0 C
                                                                                                CNDUCTVY/FIELD MICROMHOS ALUMINUM, DISS (MG/L-AL) SILVER, DISS (MG/L AS AG)
                                                                                                                                                                       3362.
TEMPERATURE, AIR (C)
FIELD PH
NICKEL, DISS (MG/L AS NI)
LEAD, DISS (MG/L AS PB)
CTRONTIUM, DISS (MG/L AS TI)
VANABIUM, DISS (MG/L AS V)
ZINC, DISS (MG/L AS ZN)
ZIRCONIUM DIS (MG/L AS ZR
ARSENIC, DISS (UG/L AS AG)
SELENIUM, DISS (UG/L SE)
                                                                                                                                                                        580.
                                                                          3.58
                                                                                                                                                                              .007
                                                                                                SILVER,DISS (MG/L AS AG)
BORON ,DISS (MG/L AS E)
CADMIUM,DISS (MG/L AS ED)
CHROMIUM, DISS (MG/L AS CD)
COPPER,DISS (MG/L AS CU)
CITHIUM,DISS(MG/L AS CU)
MOLYEDENUM,DISS(MG/L AS HG)
HERCURY,DISS(UG/L AS HG)
ACTRITY,TOT(MG/L CACO3)
                                                                          <.04
1.16
.050
                                                                                                                                                                              ,10
                                                                                                                                                                              1034
                                                                        13.3
                                                                                                                                                                              . 65
                                                                         77.3
                                                                                                                                                                               .04
                                                                          2.1
REMARKS: CLEAR WATER - NO PRECIPITATE *
                     SPRING RISES FROM WITHIN SPOIL PILE JUST SW OF HINE ABIT " SOUTH OF SAND COULEE * TRICKLE FROM ABIT BISCHARGE * HF=28.1 HOZL * 27.9 HERVSZL * SIGHA 15.5, 128.8 TOTAL CATION HERVSZL
EXPLANATION: HG/L = MILLIGRANS PER LITER, UG/L = MICROGRAMS PER LITER, HEG/L MILLIERUIVELENTS PER LITER. FT = FEET, HT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. FOT = TOTAL.
```

PERCENT MEGAL (FOR PIPER PLOT)
DA MG NA K DL 504 H003
55 55:2 3:2 0:1 0:1 77:7 0:0 CA #G 37,5 59,2 0.0

WA

QW

LAST EDIT DATE: 04-MAY-81 PROCESSING PROGRAM: F1730P V2 (11/3/81)

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT:

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAW NUMBER: 8002322

92

- 4.5 T

- 8

E. M

AT

COST:

PRINTED:

BY:

OTHER

TP *CLC

0.03

27 - HAY -- 83

HONTANA BUREAU OF MINES AND GEOLOGY WATER QUALITY ANALYSIS BUTTE, MONTANA 59701 (406)496-4101

LAB NO. 8082323

STAFE MONTANA COUNTY CASCADE OUTE LOCATION 18M 4E 14 ALCO MBMG SITE RS 01 STATION IB 471847111110701 SAME: E SOURCE MINE BRAINAGE JUREACE ALTITUDE 3860. ET 10 GUSTAINED YIELD 47018'47'N 111011'09'N 712 N5239770 F485940 SERING COULEF 7 1/2' LATITUDE-LONGTTUDE UTH COURDINALES TOPOGRAPHIC MAP GEOLOGIC SOURCE DRAINAGE RASIN LAND SURFACE AL 201HRSN# * E: D: BRAINAGE HASIN
ASENCY + SAMPLER
ROTTLE NUMBER
DATE SAMPLED
LAB + ANALYST
BATE ANALYST
BATE ANALYST
SAMPLE HANDLING MBMG*JJD ES 01 20 SEP 80 15:00 HOURS YIELD MEAS METHOD TOTAL DEPIL OF WELL TOTAL REPHI OF WELL AROVE (-) OR RELOW GO CASING PLANETER CASING TYPE COMPLETION TYPE PERFORATION INTERVAL MBMG*FNA 18-FEB-81 1120 METHOD SAMPLED GRAD WATER USE UNUSED

SAMPLING SITE SAND COULEE MINING DISTRICT*NO FIVE CREEK GCOLOGIC SOURCE MORRISON FORMATION

CALGIUM (CA) MAGNESIUM (MG) SODIUM (NA) POTASSIUM (N) IRON (FE) MANGANESE (MN) SILICA (SIO2)	MG/L 121. 41.69 52.5 52.5 20.6	3.42 0.35 0.15 3.36	RICARBONATE CARBONATE CHLORIDE SULFATE NITRATE FLUORIDE PHOSPHATE TOT	(CL) (SG4) (AS N) (E)	MS/I. 548. 4.02	0.10 11.41 0.06
TOTAL CATIONS		13.63	JATOT	ANIONS		11.56

STANDARD DEVIATION OF ANION CATION BALANCE (SIGHA)

LABORATORY PH TOTAL HARBNESS AS CACOS 3.32 173.36 TOTAL ALKALINITY AS CACOJ SOBIUM ADSORPTION RATIO RYZNAR STABILITY INDEX FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT 0.30 SPEC.COND. (HICROMHOS/CM) LANGLIER SATURATION INDEX 1209.

PARAMETER	VALUE	PARAMETER	VALUE
TEMPERATURE: AIR (C)	16.0 0	CNRUCTVY/FIELD MICROPHOS	1122.
FIELD PH	5,41	ALUMINUM: DISS (MG/L:AL)	3.04
NICKEL DISS (MG/L AS NI)	.30	SILVER/RISS (MS/L AS AS)	<.002
LEAD, DISS (MS/L AS PB)	< . 04	BORON FDISC (MG/L AS B)	.06
STRONTIUM, DISS (MS/L-SR)	.31	CADMIUM;DISS(MSZL AS CD)	.005
TITANIUM DIS(MS/L AS TI)	.013	CHROMIUM, DISS (MG/L-CR)	,004
VANADIUM, DISS(HG/L AS V)	.009	COPPER,DISS (MO/L AS DU)	.013
ZINC>DISS (MS/L AS ZN)	1.23	LITHIUM, DISS(MG/L AS LI)	.062
ZIRCONIUH DISCHGZL AS ZR	<.004	HOLYBUENUM/DISS(MOZL-MO)	€.07
ARSENIC: DISS(UG/L AS AS)	1.7	MERCURY, DISS(UG/L AS HG)	.04
SELENIUM, DISS (UG/L-SF)	. 3	ACIDITY, TOT (MG/L -CACG3)	108.

REMARNS: WATER TURBID - SLIGHTLY MILKY * RECOMES PALE TO BRIGHT GRANGE UPON

MIXING * GRIFFEN MINE OUTFLOW RS-01 *
SAMPLE TAKEN FROM OUTFLOW FROM ABIT *
LAB: HF=0 MG/L, -2,2 SIGHA, 12,4 TOTAL CATION MERVS/L *

CXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, HEG/L = MILLIFGULVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED, TR = FOTAL RECOVERABLE, TOT = TOTAL.

QW WA 52 UI 0 ₩ F'U AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: RY! LAST EDIT DATE: TP *CLG 04 - MAY 31 PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTERS 27 HAY 83

> PERCENT MEDIAL (FOR PIPER PLOT) NA A CL SD4 HC03 5.3 1.5 0.7 77.1 0.0 EA MG 58.7 33.4 003 5.3

WATER QUALITY ANALYSIS

LAE NO. 8100060 STATE MONTANA COUNTY CASCADE LATITUDE-LONGITUDE 47D18'47'N 111D11'05'W SITE LOCATION 18N 4E 14 ACCD UTH CORDINATES ZI2 N5237780 E486070 H8MG SITE BS-01 TOPOGRAPHIC MAP STOCKETT 7 1/2' STATION ID 471847111110501 GEGLOGIC SOURCE 221MRSN* * SAMPLE SOURCE HINE DRAINAGE DRAINAGE BASIN BR LAND SURFACE ALTITUDE 3840. FT < 10 4E 14 ACCD LAND SURFACE ALTITUDE SUSTAINED YIELD 10 AGENCY & SAMPLER UPF # SHEH BENUT & SAMPLER BROWNED BOTTLE NUMBER BS-01
DATE SAMPLED 03-MAR-81
TIME SAMPLED 15:00 HOURS
LAB & ANALYST MRMG*FNA
DATE ANALYZED 22-APR-81
SAMPLE HANDLING 4120
METHOD SAMPLED GRAB YIELD HEAS HETHOD
TOTAL DEPTH OF WELL
SWL ABOVE(-) OR BELOW GS
CASING DIAMETER
CASING TYPE
COMPLETION TYPE 15:00 HOURS PERFORATION INTERVAL UNUSED WATER USE SAMPLING SITE STOCKETT " SAND COULEE MINING DISTRICT GEOLOGIC SOURCE HORRISON FORMATION MG/L 34.7 MEQZI. MG/L **HER/L** 3.23 BICARBONATE (HC03) CAUCIUM (CA) 22.4 7.7 4.2 27.1 (003) MAGNESIUM (HG) SODIUK (NA) 0.33 CHLORIDE (CL) 4.8 0.14 0.11 SULFATE 1.55 NITRATE (K) (FE) 632, 11 1.23 POTASSIUM (SO4) 13.16 IRON (AS N) HANGANESE (HN) 0.01 FLUDRIDE (F) 0.05 SILICA (SIG2) 10.6 PHOSPHATE TOT (AS P) TOTAL CATIONS 7.05 TOTAL ANIONS 13.37 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA) 3.62 TOTAL HARDNESS AS CACO3
7.9 C TOTAL ALKALINITY AS CACO3
SOBJUM ADSORPTION RATIO
RYZNAR STABILITY INDEX
14. LANGLIER SATURATION INDEX LARORATORY PH 253.75 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT LAB SPEC.COND. (HICROMHOS/CH) 0.21 1984. VALUE VALUE PARAMETER PARAMETER
CNDUCTVY, FIELD HICROMHOS
ALKALINITY, FLECA GS CACC3)
IRON, TR (MS/L AS FE)
ARSENIC, TR (UG/L AS AS)
ALUMINUM, DISS (MG/L AS AS)
BORON, DISS (MG/L AS AS)
CABHIUM, DISS (MG/L AS CD)
CHROMIUM, DISS (MG/L AS CD)
CHROMIUM, DISS (MG/L AS CD)
COPPER, BISS (MG/L AS CD) PARAMETER 10. C 5.37 TEMPERATURE, AIR (C) 1038. 50.4 FIELD PH 1.72 30.2 5.2 1.16 ALUMINUM, TR (HG/L AS AL) ALUMINUM, TR (MG/L AS AL)
ACIRTTY, TOT (MG/L CACO3)
SELENIUM, TR (UG/L AS SE)
NICKEL, RISS (MG/L AS NI)
LEAR, RISS (MG/L AS PR)
STRONTIUM, RISS (MG/L AS TI)
VANABIUM, RISS (MG/L AS TI)
VANABIUM, RISS (MG/L AS TI)
ZINC, RISS (MG/L AS ZR
ARSENIC, RISS (UG/L AS AS) 403.8 .05 .170 .012 .055 .057 .14 .040 COPPER, DISS (MG/L AS CU) LITHIUM, DISS (MG/L AS LI) MOLYRDENUM, DISS (MG/L-MO) SELENIUM, DISS (UG/L-SE) .042 .600 .074 <.1

REMARKS: WATER SLIGHTLY TURBIB -- BUT LITTLE ORANGE FILTERATE * GIFFEN HINE OUTFLOW -- AT ABIT * LAB: 13.7 CATION HEOVS. -- 25 SIGMA, 12.2 MG/L EST. HF *

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MC HILLIEQUIVELENTS PER LITER. FT = FEET, MT = MCTERS. (M) = MCASURED, (C) = HER/L

QW. WA 52 WI 011 ΔT CTHER OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: LAST CDIT DATE: 29-APR-81 BY: TP *CLG PROCESSING PROGRAM: F1739F V2 (11/3/81) PRINTED: 27.8AY.83

> PERCENT HERZL (FOR PIPCR PLOT) CA MG NA K CL 804 HC03 CA 0.03 2.0 1.0 77.0 0.0 58.5 33.4 5.1 0.0

WATER QUALITY ANALYSIS LAB NO. 8082324

```
CTATE MONTANA
LATITUDE LONGITUDE 47D18'40'N 111D11'13'W
UTH COORDINATES 712 N5237640 F485050
TOPOGRAPHIC MAP STOCKETT 7 1/2'
                                                                                                                   COUNTY CASSARE
                                                                                                   SITE LOCATION 18N 4E 14 CAAD HANG SITE RG-02 STATION 10 471840111111301 SAMPLE SOURCE SPRING
        DRAINAGE BASIN BE
AGENCY + SAMPLER MBMG*JJD
BGTTLE NUMBER BS-02
DATE SAMPLED 21-SEP-80
TIME SAMPLED 13:00 HGURS
LAR + ANALYST MBMG*FNA
05-DEC-80
                                                                                   LAND SURFACE ALTITUDE SUSTAINED YIELD
                                                                                                                                   3860.
                                                                                                                                                F7 - 10
                                                                                           YIFLD HEAS METHOD
                                                                            TOTAL REPTH OF WELL
SWL AROVE() OR RELOW OS
CASING DIAMETER
          TIME SAMPLER 13:00 HOURS
LAB + ANALYST MRMG*FNA
DATE ANALYZED 05-DEC-80
SAMPLE HANDLING 4120
METHOD SAMPLED GRAD
WATER USE UNUSED
                                                                                    CASING TYPE
COMPLETION TYPE
PERFORATION INTERVAL
           SAMPLING SITE SAND COULFE MINING DISTRICT * NO. FIVE CN GEOLOGIC SOURCE MORRISON FORMATION
                                                                                                                                    187.7 MEG/L
                                               MG/L
                                                                MERZI.
        CALCIUM
                             (CA)
                                              167.
                                                                    8.33 BICARBONATE
                                                                                                               (HC03)
                                                                                                                                                       3.00
        MAGNESIUM
                                                                     4.10 CARBONATE
0.73 CHLORIDE
                                                                                                                                       0.
                             (MG)
                                                                                                               (003)
         SODIUM
                                                 21.3
                                                                                                                  (CL)
                              (NA)
                                                                                                                                                        0.17
                                                                    0.15 SULFATE
1.87 NITRATE
0.04 FLUORIDE
        COTASSIUM
                               (K)
                                                   5.68
                                                                                                                                    450.
                                                                                                                 (504)
                                                                                                                                                       10.20
                                                 34.8
                                                                                                                                      .57
         IRON
                                                                                                                                                       0.04
                                                                                                               (AS N)
        MANGANESE (MN)
                                                                                                                     (F)
                                                                                                                                          .87
                                                                                                                                                         0.05
        SILICA (SIG2)
                                                   8.2
                                                                                PROSPHATE TOT (AS F)
             TOTAL CATIONS
                                                                   15.42
                                                                                                TOTAL ANIONS
                                                                                                                                                       13.54
            STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                           (SIGHA)
                                                                                                                                          5,94
  LABORATORY PH
FIGUR WATER TEMPERATURE
CALCULATED DISSOLVED SOLIDS
SUM OF DISS. CONSTITUENT
LAB SPEC.COND.(MICROMHOS/CM)
                                                                        6.67 TOTAL HARDNESS AS CACOS
                                                                                                                                                 622.39
                                                               11.4 C TOTAL ALKALINITY AS CACO3
878.14 SODIUM AUSORPTION RATIO
973.48 RYZNAR STABILITY INDEX
1144. LANGLIER SATURATION INDEX
                                                                                                                                                 154.11
                                                                                                                                                 0.37
                                                            VALUE

10.0 C
CNDUCTVY,FIELD HICROHHOS

5.57
ALUMINUM, DISS (MG/L-AL)

21LVER,DISS (MG/L AS AS)

1.31
CADMIUM,DISS (MG/L AS CB)

CHROHIUM, DISS (MG/L-CR)

4
COPPER,DISS (MG/L AS CU)

LITHIUM,DISS (MG/L AS CU)

LITHIUM,DISS (MG/L-AS LI)

HOLYBDENUM,DISS (MG/L-MD)
TEMPERATURE, AIR (C)
                                                                                                                                                VALUE
                                                                                                                                               1124.
FIELD SH
TIELD PH
STRONTIUM, DISS (MG/L-SR)
TITANIUM DIS(MG/L AS TI)
ZINC, DISS (MG/L AS ZN)
ZINCONIUM DIS(MG/L AS ZN
SELENIUM, DISS (UG/L-SE)
                                                                                                                                                   <.002
                                                                                                                                                    .05
                                                                                                                                                   .004
                                                                                                                                                     .002
                                                                                                                                                     .014
```

REMARNS: WATER LOOKS PALE GRANGE * ORANGE AND WHITE PRECIPITATE IN FILTER *
R. SINGLES SPRING - GIFFEN HINE * SPRING EMITS OVER BROAD AREA NEAR
WHERE MINE ADIT WAS PLUGGED TO SHUTOFF ACID MINE DISCHARGE *
LAB: FU FE OF .017 MG/L GIVES -.035 SIGMA *

.34

EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, HER/L HILLIEGUIVELENTS PER LITER. FT = FEET, HT = HETERS, (H) = HEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

GM WA 52 WI OW PW AT OTHER

HOLYADENUM, DISS(HS/L-HO) LEAD, DISS (HG/L AS PB)

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

ARSENIC, DISS(UG/L AS AS)
MERCURY, DISS(UG/L AS HG)
NICKEL, DISS (HG/L AS NI)
DISSLUD SOLIDS(CALC HG/L

PROJECT: COST: PROCESSING PROGRAM: 02-FEB-83 F1730P V2 (11/3/81) JKS*JKS 27-MAY-83 BY: PRINTED:

> PERCENT MEGAL (FOR PIPER PLUT) K CL 304 HC03 1.3 75.8 22.9 CA MG NA 0.03 30.4 6.5 1.1 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: BOG2324

.044

<.02

WATER QUALITY ANALYSIS LAS NO. SOR2325

STATE MUNTANA COUNTY CASCADE LATITUDE-LONGITUDE 47D24'43'N 111D09'03'W SITE LOCATION 17N SE 7 CACE UTH COORDINATES ZI2 N5250740 E488590 TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1 # SAMPLE SOURCE MINE BRAINAGE
LAND SURFACE ALTITUDE 3490. FT < 10
SUSTAINED YIELD GEOLOGIC SOURCE DRAINAGE BASIN 221MR5N* * EB NCY + SAMPLER BOTTLE NUMBER MBMG*JJD AGENCY SUSTAINED YELLD
YIELD HEAS METHOD
TOTAL DEPTH OF WELL
SWL ABOVE(-) OR BELOW GS
CASING DIAMETER
CASING TYPE
COMPLETION TYPE GENCY 4 SAMPLER 08-0

BOTTLE NUMBER 08-0

DATE SAMPLED 21-50

TIME SAMPLED 08:00

LAB 4 ANALYST MBMG

DATE ANALYZED 18-F0

SAMPLE HANDLING 4120

HETHOD SAMPLED ORAN 08-01 21-5EP-80 08:00 HOURS MBMG*FNA 18-FEB-81 PERFORATION INTERVAL WATER USE UNUSED SAMPLING SITE SAND COULEE MINING DISTRICT*SAND COULEE CK SECLOGIC SOURCE MORRISON FORMATION MG/L HER/L HG/1. HER/L 93.5 74.7 22.3 12.4 4.67 CALCIUM (CA) BICARBONATE (HC03) 6.15 CARBONAT MAGNESIUM (MG) CARBONATE (003) SODIUM (NA) (CL) 5.3 0.10 0.06 SULFATE NITRATE 780. POTASSIUM (K) (504) 20.40 . 0 4 (AS (R) IRON (FE) 0.00 .85 MANGANESE (MN) 0.03 FLUCRIDE 0.18 3.4 SILICA (SIO2) 33.5 PHOSPHATE TOT (AS P) TOTAL CATIONS 12:54 TOTAL ANIONS 20.73 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA) LABORATORY PH 2.93 TOTAL HARDNESS AS CACO3 540.93

10.5 C TOTAL ALKALINITY AS CACGZ SODIUM ADSORPTION RATIO RYZNAR STABILITY INDEX FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT LAB SPEC.COND. (MICROMHOS/CM) 0.42 1839. LANGLIER SATURATION INDEX

PARAMETER	VALUE	PARAHETER	VALUE
TEHRERATURE: AIR (C)	10.0 C	CNDUCTVY/FIELD MICROMHOS	1862.
FIELD PH	2+88	ALUMINUH, DISS (MG/L-AL)	47.5
NICKEL DISS (MG/L AS NI)	.54	SILVER, DISS (MG/L AS AG)	<.002
LEAD, DISS (MG/L AS PB)	< . 04	BORON DISS (MG/L AS B)	.12
STRONTIUM, DISS (MG/L -SR)	33.	CADMIUM, DISS(MG/L AS CD)	.018
TITANIUM DIS(MS/L AS TI)	.016	CHROMIUM, DISS (MG/L-CR)	.005
VANADIUM: DISS(MG/L AS V)	.006	COPPERIDISS (MG/L AS CU)	.030
ZING DISS (HG/L AS ZN)	1.55	LITHIUM, DISS(MG/L AS LI)	1.17
ZIRODNIUM DISCHG/L AS ZR	<.004	MOLYXDENUMADISS(MOZL-MO)	<.02 <.03
ARSENIC, DISS(UG/L AS AS)	1.5	MERCURY,DISS(UG/L AS HG) ACIDITY,TOT(MG/L-CACO3)	432.
SELENIUM, DISS (UG/L-SE)	• 4	HOTELLIA LOLGOVE CHOOS	402.1

REMARKS: CLEAR WATER - COLORLESS * EFFLUENT FROM WOODEN DRAIN PIPE FROM ADIT - BURIED UNDER SPOIL * LAB: H+=3.2 MG/L, .38 SIGMA, 20.5 TOTAL CATION MEDVS/L *

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L MILLIEGUIVELENTS PER LITER. FT = SEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

> U.N. MA 32 IJ T OW AT DIMER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: LAST EDIT DATE: PROCESSING PROGRAM: 04-MAY-31 BY: TP *CLG - říz30ř V2 (11/3/81) 27 - MAY - 83 PRINTED:

> PERCENT MEGYL (FOR PIPER PLOT) CL S04 HCC3 CA MG 37.4 51.9 MG 003 NA 0.5 8.2

STATE MONTANA CGUNTY CASCASE
LATITUDE-LONGITUDE 47820'12'N 111009'11'W SITE LOCATION 18N SF & CCAC
UTH COORDINATES 712 N5242350 E488510 MBMG SITE CS 09
TOPOGRAPHIC MAP STOCKETT 7 1/2' STATION ID 472012111091101
GCOLOGIC SOURCE 221HRSN*111SPRN* * SAMPLE SOURCE MINE DRAINAGE UTH COORDINATES
TOPOGRAPHIC MAP
GCOLOGIC SOURCE
DRAINAGE BASIN
AGENCY + SAMPLER
BOITLE NUMBER LAND SURFACE ALTITUDE SUSTAINED YIELD EE dri'*3hgh 3850. FT = 10 YIELD MEAS METHOD
TOTAL DEPTH OF WELL
SWL ABOVE() OR BELOW GS
CASING DIAMETER
CASING TYPE
COMPLETION TYPE 21 SEP 30 15:00 HOURS HBMG*FNA BOTTLE NUMBER
DATE SAMPLED
TIME SAMPLED
LAB F ANALYST
DATE ANALYZED
SAMPLE HANDLING
METHOD SAMPLED 18-FCE-81 4120 t PERFORATION INTERVAL GRAS WATER USE UNUSED SAMPLING SITE SAND COULEE MINING DISTRICT*COTTONWOOD CK GEOLOGIC SOURCE MORRISON FORMATION MEG/: HG/I 345. 149. 14.7 1057. 2.46 113.0 17.22 BICARBONATE 12.26 CARBONATE 0.64 CHLORIDE 0.02 SULFATE CRC03) CALCIUM (CA) MAGNESIUM (MG) (003) SOBIUM (NA) (CL) 17.4 0.47 6480. (K) (FE) POTASSIUM (304) 134.71 MANGANESE (MN) 53.78 NITRATE 0.09 FLUGRIDE (AS N) 0.00 .06 0.05 PHOSPHATE TOT (AS P) TOTAL CATIONS 87.00 TOTAL ANIONS 135.45 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA) 2.50 LARDRATORY PH TOTAL HARDNESS AS CACO3 1474,75 FIELD NATER TEMPERATURE 10.2 C TOTAL ALKALINITY AS CACGG SOLUTION CONSTITUENT SUM OF DISS. CONSTITUENT RYZNAR STABILITY INDEX LAB SPEC.COND.(MICROMHOS/CH) 6287. LANGLIER SATURATION INDEX 0.17 VALUE 7.0 C 2.45 12.4 <.04 1.06 .077 .21 VALUE PARAMETER VALUE PARAMETER CHRISTIAN
CHRISTIAN
CHRISTIAN
ALUMINUM, DISS (MG/L AL)
SILVER, DISS (MG/L AS AS)
BORON, DISS (MG/L AS B)
CADMIUM, DISS (MG/L AS CD)
CHROMIUM, DISS (MG/L AS CD) 6747. 479. TEMPERATURE, AIR (C) TEMPERATURE, AIR (C)
FIELD PH
NICKEL, DISS (MG/L AS NI)
LEAD, DISS (MG/L AS PB)
STRONTIUM, DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS TN)
ZIRCONIUM DISS (MG/L AS ZR
ARSENIC, DISS (UG/L AS AS)
SELFNIUM, DISS (UG/L SE) .017 COPPER, DISS (HG/L AS CU) LITHIUH, DISS (HG/L AS LI) 32.9 .70 2.8 MOLYEDENUM, DISS(MG/L-MG) MERCURY, DISS(UG/L-AS-HG) ACIDITY, TOT(MG/L-GACG3) .05 <.03 REMARKS: WATER DUMPING ORANGE AND RED PRECIPITATE * CLEAR AT SOURCE *
1.5 MILES SOUTH STOCKETT * SPRING EMITS FROM SPOIL PILE IN FRONT OF
CAVED ADIT * FLOW MEASURED AT ROAD - GREATER AT SOURCE *
LAB: HF=31 MG/L, -.22 SIGMA, 135.9 TOTAL CATION MERVS/L *

EXPLANATION: HG/L = HILLIGRANS PER LITER, UG/L = HICROGRANS PER LITER, HEG/L = HILLIGROUPELENTS PER LITER. FT = FEET, HI = HETERS. (H) = HEACURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

QW WA 82 UI nu PW AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: LAST EDIT DATE: PROCESSING PROGRAM: COST: TP *CLC 04 - MAY - B1 BY: E17308 V2 (11/3/81) 27-MAY 83 PRINTEDE

> PERCENT HERZL (FOR PIPER PLOT) CA MG NA K GL 904 HC03 CA MG CL 804 HC63 0.4 99.8 0.0 K 57.1 0.1

IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8082327 NOTE: Reads

WATER QUALITY ANALYSIS

```
STATE MONTANA COUNTY
LATITUDE-LONGITUDE 47D20'12'N 111D09'10'N SITE LOCATION
UTH COORDINATES Z12 N5242395 E488515 MBMG SITE
TOPOGRAPHIC HAP STOCKETT 7 1/2' STATION ID
GEOLOGIC SOURCE 221MRSN*111MTLG* * SAMPLE SOURCE
DRAINAGE BASIN BB LAND SURFACE ALTITUDE
AGENCY + SAMPLER HBMG*UJD SUSTAINED YIELD
AGENCY + SAMPLER HBMG*UJD YIELD HEAS METHOD
POTTLE NUMBER CS-09 YIELD HEAS METHOD
                                                                                                                                           18N 5E 6*CCAC
CS-09
472012111091001
HINE DRAINAGE
                                                                                                                                              3855. FT <
                                                                                                                                                                         10
           DATE SAMPLED 03-MAR-81 TOTAL DEPTH OF WELL
TIME SAMPLED 14:00 HOURS SWI. ABOVE(-) OR BELOW OS
LAB + ANALYST MEMG*ENA CASING DIAMETER
DATE ANALYZED 22-AFR-81 CASING TYPE
SAMPLE HANDLING 4120 COMPLETION TYPE
             HETHOR SAMPLED GRAD
                                                                                           PERFORATION INTERVAL
                        WATER USE
                                               UNUSED
           CAMPLING SITE STOCKETT - SAND COULEE MINING DISTRICT SECURGE SOURCE MORRISON FORMATION
                                                                                                                                                              HEQ/L
                                                  MG/L
                                                                                                                                             MG/L
                                                                       17.96 BICARBONATE
12.75 CARBONATE
0.61 CHLBRIDE
        CALCIUM (CA)
                                                  330.
                                                                                                                       (R003)
         MAGNESIUM (MG)
                                                 155.
                                                                                                                        (CF)
         SODIUM
                                (NA)
                                                                                                                                                                0.05
143.78
0.01
0.39
                                                                                                                                                  1.9
                                                1035.
2.56
106.0
                                                                         0.07 SULFATE
57.21 NITRATE
0.09 FLUGRIDE
                                                                                                                                           6508.
         POTASSIUM
                               (R)
                                                                                                                         ($04)
                                                                                     NITRATE
FLUORIDE
                                                                                                                        (AS N)
         IRON
         IRON (FE)
MANGANESE (MN)
                                                                                                                                                  7.46
         SILICA (SIG2)
                                                                                       PHOSPHATE TOT (AS P)
             TOTAL CATIONS
                                                                         88.70
                                                                                                        TOTAL ANIONS
                                                                                                                                                                144.24
             STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA)
                                    LABORATORY PH
                                                                             2.82
                                                                                               TOTAL HARDNESS AS CACO3 1536.90
                                                                      8.6 C TOTAL ALKALINITY AS CACOJ
SODIUM ADSORPTION RATIO
RYZNAR STABILITY INDEX
6251. LANGLIER SATURATION INDEX
    FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT
                                                                                                                                                               0.16
  LAB SPEC.COND. (HICROMHOS/CH) 6251.
                                                                  VALUE
                                                                                                         PARAMETER
                                                                                                                                                           VALUE
                                                             10. C
2.53
1270.
TEMPERATURE, AIR (C)
                                                                                                                                                      6826.
1270.
5431.
                                                                                        CHRUCTVY, FIELD HICROMHOS
                                                                                       CNDUCTVY, FIELD MICROMHOS ALUMINUM, TR (MG/L AS AL) ACIBITY, TOT (MG/L AS AL) SELENIUM, TR (UG/L AS SE) NICKEL, DISS (MG/L AS NI) UEAD, RISS (MG/L AS PR) STRONTIUM, DISS (MG/L AS TI) VANADIUM, DISS (MG/L AS V) TINC, DISS (MG/L AS ZR ARSENIC, DISS (UG/L AS AS)
HS GUBIS
FIELD PH
IRON, TR (MO/L AS FE)
ARSENIC, TR (UG/L AS AS)
ALUMINUM, DISS (MO/L AL)
SILVER, DISS (MG/L AS AG)
DORON, DISS (MG/L AS AG)
CARMIUH, DISS (MG/L AS CD)
CHROMIUH, DISS (MG/L AS CD)
CHROMIUH, DISS (MG/L AS CD)
                                                                                                                                                           .B
12.8
(.04
                                                                   6.0
                                                                500.022
                                                                      .33
                                                                                                                                                              .103
                                                                                                                                                               .014
COPPER, DISS (MG/L AS CU)
LITHIUM, DISS (MG/L AS LI)
MOLYRDENUM, DISS (MG/L-MO)
                                                                      .154
                                                                                                                                                             4.35
                                                                    .728
1.42
                                                                                                                                                               .025
                                                                                                                                                              5.0
SELENIUM, DISS (US/L-SE)
                                                                      .6
```

REMARKS: SAMPLE CLEAR -- NO PRECIPITATE * DOWNSTREAM THERE IS GRANGE AND WHITE PRECIPITATE AND GREEN SLIME * SAMPLE FROM SPRING AT SPOIL PILE BY THE MINE * AT ROAD, PH=2.72, S.C.=6725 *

EXPLANATION: HG/L = HILLIGRARS PER LITER, UG/L = HICROGRAMS PER LITER, HEG/L HILLIEQUIVELENTS PER LITER. FT = FEET, HT = HETERS. (H) = HEASURED, (E) = ESTIMATED, (R) = REPORTED. <math>TR = TOTAL RECOVERABLE. TOT = TOTAL.

GM. 52 WI CW AT RIBER OTHER AVAILABLE DATA OTHER FILE NUMBERS: Y

COST: PROJECT: LAST EDIT DATE: PROCESSING PROGRAM: 17-558-62 SY: TP *JKS F1730F V2 (11/3/81) 27 - MAY - 83 PRINTED:

> PERCENT HER/L (FOR PIPER PLOT)
> CA HG NA K CL 984 HCC
> 7-2 40-3 2-0 0-2 0-0100-0 0. Ct. 984 HC03 57.2 40.6 0.0 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8100061 ANALYSIS NOT IN FILE: 8101000

```
STATE NONTANA

FITUDE-LONGITUDE 47D23'21'N 111D07'59'W SITE LOCATION 19N 5E 20 BBBC

UTH COORDINATES 712 N5248170 F489950 MBMG SITE DS-01

FORDORAPHIC MAP SOUTHFAST GREAT FALLS 7 1 STATION ID 472321111075901

GEOLOGIC SOURCE 221HRSN*1115PBN* * SAMPLE SOURCE MINE DRAINAGE

DRAINAGE BASIN BB LAND SURFACE ALTITUDE 3590. FT 1 50

GENCY + SAMPLER MBMG*JJD SUSTAINED YIELD

DOTTLE NUMBER CS-05 YIFLD MEAS METHOD

DATE SAMPLED 21-SEP-30 TOTAL DEPTH OF WELL

TIME SAMPLED 10:00 HOURS SWL ABOVE(-) OR BELOW GS

LAB + ANALYSE MBMG*FNA CASING DIAMETER

DATE ANALYSE MBMG*FNA CASING TYPE

SAMPLE HANDLING 4120 COMPLETION TYPE *

METHOD SAMPLED GRAB PERFORATION INTERVAL

WATER USE UNUSED
     LATITUDE-LONGITUDE
UTH COORDINATES
IOFOGRAPHIC MAP
GEOLOGIC COURSE
           GEOLOGIC SOURCE
DRAINAGE BASIN
AGENCY + SAMPLER
                              WATER USE UNUSED
                   SAMPLING SITE SAND COULEE MINIMO DISTRICT*SAND COULEE CK
             GEOLOGIC SOURCE MORRISON FORMATION
                                                             MG/L
                                                                                      HER/L
                                                                                                                                                                           MOZI. MERZI.
                                                    31.

62.6

13.6

2.4

31.3

.70

98.2
                                                                                          7.03 BICARBONATE (HCO3)
5.15 CARBONATE (CO3)
0.57 CHUORIBE (CL)
           CALCIUM (CA)
           MAGNESTUH (MG)
                                                                                                                                                                     1437.
                                                                                                                                                                                                   0.15
            SODIUH
                                      (NA)
           FOTASSIUM (K)
IRON (FE)
MANGANESE (MN)
SILICA (SIO2)
                                                                                                                                                                                              25.52
                                                                                          0.06 SULFATE
                                                                                                                                                  (804)
                                                                                          1.38 NITRATE
0.03 FLUORIDE
                                                                                                                                                (AS N)
                                                                                                                                                        (F)
                                                                                                        PHOSPHATE TOT (AS P)
                                                                                        16.54
                 TOTAL CATIONS
                                                                                                                             TOTAL ANIONS
                                                                                                                                                                                                    30.25
                 STANDARD REVIATION OF ANION CATION BALANCE (SIGMA)
                                            LABORATORY PH 2.31 TOTAL HANDRESS HS CACOS
TEMPERATURE 11.0 C TOTAL ALKALINITY AS CACOS
CONTUR AUSGRETION RATIO
                                                                                          2.31 TOTAL HARDNESS AS CACO3 709.62
  FIELD NATER TEMPERATURE LI.C CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT LAB SPEC.COND. (MICROMHOSZCM) 2922.
                                                                                                                    SODIUM AUSCRETION RATIO
                                                                                                              RYTHAR STABILITY INDEX
LANGLIER SATURATION INDEX
                                                                               VALUE
                                                                               PARAMETER

8. C CNDUCTVY, FIELD HICROMHOS

2.50 ALUMINUM, DISS (MG/L-AL)

.34 SILVER, DISS (MG/L-AS AC)

<.04 BORGN, DISS (MG/L-AS B)

.73 CADMIUM, DISS (MG/L-GR)

.033 CHROMIUM, BISS (MG/L-GR)

.016 COPPER, DISS (MG/L-AS CU)

1.04 LITHIUM, DISS (MG/L-AS LI)

.005 MOLYBDENUM, DISS (MG/L-MG)

<.1 MERCURY, DISS (UG/L-AS MG)

.4 ACIDITY, TOT (MG/L-CACO3)
                                                                                                                                                                                           VALUE
PARAMETER
TEMPERATURE, AIR (C)
                                                                                                                               PARAMETER
                                                                                                                                                                                         3027.
FIELD PH
FIELD PH
NICKEL, DISS (MG/L AS NI)
LEAD, BISS (MG/L AS PS)
STRONTIUM, DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS TN)
ZINC, DISS (MG/L AS TN)
ZIRCONIUM DIS (MG/L AS TR
ARSENIC, DISS (UG/L AS AS)
SELENIUM, DISS (UG/L-SE)
                                                                                                                                                                                           55.6
                                                                                                                                                                                             .006
                                                                                                                                                                                                 .10
                                                                                                                                                                                               .016
                                                                                                                                                                                                 .035
```

REMARKS: WATER IS MURKY - FILTERS POORLY DUE TO SEDIMENT * WATER SEEPS OVER DROAD AREA OF MINE SPOIL * SOME MIXING WITH HIGHER PH * NATURAL SPRING DISCHARGE (PH FROM 3-5) * OUTFLOW AT ROAD AT 16PH, PH=2.78 * WATCR LAB: SEEPS RAPIDLY BACK INTO GROUND ALONG DRAINAGE CHANNEL * LAB: H+=11.3 MG/L, ...01 SIGMA, 30.3 TOTAL CATION MEGVS/L *

EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, HEG/L = HILLIEGUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

문規 AT GM WA 5.2 LI T CH GTHER

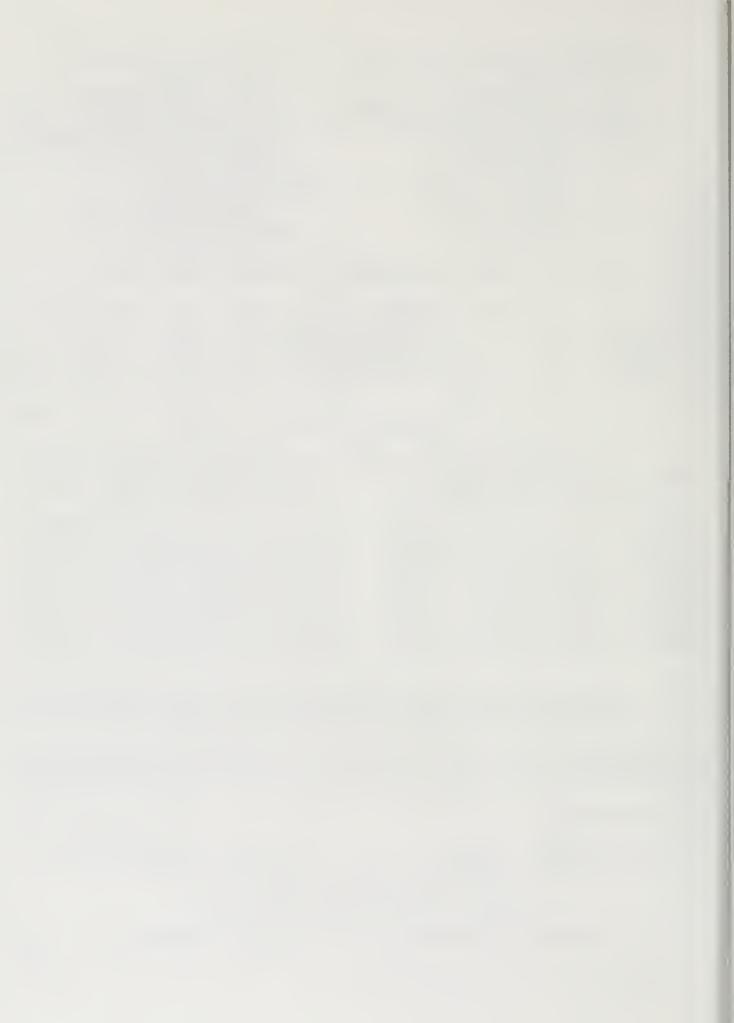
OTHER FILE NUMBERS:

PROJECT: LAST EDIT DATE: 04-HAY-81 COST: TP *GLG 3Y: PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27 HAY-83

> PERCENT MERZL (FOR PIPER PLOT)
> CA MG NA K CL 504 HC03 CO3
> CP 34.7 4.0 0.4 0.5 77.5 0.0 0.0 CA HG NA 60.7 34.7 4.0

HOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8002326

.17 <.02



APPENDIX B

GEOLOGY

A comprehensive description of the Mesozoic stratigraphy of the area is presented in Silverman and Harris (1967), and comments regarding the geology of the area are largely derived from their report and from field inspection.

B.1 Madison Group (Mississippian)

The Madison Group is the oldest geologic unit exposed in the area. Its top is exposed in several localities along the bottoms of Cotton-wood, Number Five and Sand Coulees. Outcrops are not extensive; the largest observed exposure is about thirty feet thick. Feltis (1980, 3) shows the top of the Madison in this area to dip to the north-northwest at a relatively uniform dip of 50-70 feet/mile (about one degree). However, exposures in this area suggest that the top of the formation may be irregular, projecting local domes or knobs. It is probably located at shallow (<300 feet) depth in the subsurface throughout the study.

The Madison is overlain unconformably by Jurassic sediments of the Ellis Group. This unconformity is angular, as exposed 0.5 km north of Stockett, where folded Madison strata dip 25 degrees north-northeast beneath flay-lying sandstone of the Ellis. The Madison may exhibit more complex structure in the subsurface than the gently-dipping Cretaceous and Jurassic sediments which overlie it.

The lithology of the Madison is grey, coarsely-crystalline limestone and dolomitic limestone, with chert grains and a diverse

biohermal fossil assemblage. It occurs both in thin, flaggy beds and in massive biohermal strata. Some fossil casts have been refilled with either calcite or gypsum. Local residents report that the limestone is locally cavernous along Sand Coulee Creek farther south towards the mountains. Water well drillers have reported encountering cavernous zones in the upper Madison in the Stockett and Sand Coulee area.

B.2 Swift Formation and Ellis Group (Jurassic)

Sandstone of the Swift Formation, the upper member of the Ellis Group, is distinctive in outcrop as a cemented, cross-bedded, grey, massive- to flaggy-bedded sandstone. Outcrops are found along coulee bottoms in the upper reaches of the Sand Coulee Creek drainage, particularly south of Stockett. In some localities, it unconformably overlies the Madison, but it usually overlies yellow and grey shales and mudstones of the lower Ellis Group. The fine-grained sediments of the Ellis are poorly resistant to erosion and are not well exposed in the area.

B.3 Morrison Formation (Jurassic)

The Morrison Formation consists of 50-250 feet of grey mudstone, with interbedded lenses of limestone, sandstone, coal and shale. Coal mined in the Sand Coulee area is from bed(s) at or near the top of the Morrison. The uppermost coal bed is directly overlain by a cemented conglomeratic channel sandstone at the base of the Kootenai Formation (Cretaceous).

Although the upper coal seam was the primary target of mining in this area, at least one other minable seam may occur in the subsurface

of the area. In the Giffin mine workings, local residents report that mining took place at two separate levels separated by approximately 30 feet of interburden material.

Morrison outcrops are found in this area along the mid-slopes of the coulees. The upper part of the Morrison consists of coal, carbon-aceous shale and fine-grained sandstone lenses, up to a total thickness of sixty feet. The coal bed ranges from 1-12 feet thick, with varying proportions of interbedded carbonaceous shale. The thickness of these shale strata was one of the controls on the profitability of mining.

Sandstone lenses in the Morrison are up to 35 feet thick. They are clean fluvial deposits and weather orange, making them difficult to distinguish from some of the sandstones in the overlying Kootenai. Perhaps the most diagnostic characteristic of the Morrison is its varied assemblage of interbedded lithologies, including shale, mudstone, coal, sandstone and fresh water limestone.

B.4 Kootenai Formation (Lower Cretaceous)

The Kootenai Formation is a sequence of numerous lensaic, discontinuous sandstone beds from one to 50 feet thick, interbedded with green and grey mudstone. It forms the coulee walls and underlies the upland benches between coulees throughout the study area. The basal sandstone unit of the Kootenai, the Third Cat Creek equivalent in this area, overlies the coal in the Upper Morrison with an erosional unconformity. This unit represents the first coarse channel deposits of the major river system which established itself across the Upper Jurassic land surface.

Except for the basal sandstone, the numerous sandstone beds in the

upper Kootenai are relatively discontinuous. Most individual beds cannot be traced over long distances.

B.5 Glacial Deposits

According to Coulton et al. (1961), the limit of Wisconsinan continental glaciation lies just to the north of the Sand Coulee area. No known till or drift deposits occur within the valley. There is a large pre-glacial channel of the Missouri River which runs east-west from the modern Missouri River south of Great Falls, at the Sand Coulee Creek delta, directly west to the town of Fife. The flow of Sand Coulee Creek turns abruptly to the west as it encounters this channel. The channel is filled with sand, gravel, silt and clay deposited by glaciers and glacial lakes over which the lower reach of Sand Coulee Creek flows at a gentle gradient of 9-10 feet/mile (about 2%).

B.6 Alluvial Deposits

Thin alluvial deposits of Quaternary and possibly Tertiary age lie along the coulee bottoms of Straight, Cottonwood, Number Five and Sand Coulee Creeks. North of Tracy, these alluvial deposits inter-finger with the outwash and lacusterine deposits of the ancient Missouri channel. Thickness of the alluvial cover is variable. Although little data on its thickness distribution are available, it is probable that nowhere south of Tracy is it greater than 100 feet.

APPENDIX C
HYDROGEOLOGICAL DATA



DOMESTIC WELL INVENTORY FIELD SHEETS



COUNTY CASCADE T. 1								
LAT N. LONG	w.		UTM	N	Ε			
TOWN SUBDIVISION				BLOCK	LOT			
OWNER'S NAME DOIVALD TAGOB	5		ADDRESS _					
	PHONE N	UMBER_		YEAR _				
ALT. LAND SURF. AT WELL MSL 4303 H.				HOLOGIC LOG				
TOTAL DEPTH BELOW LSD 90 n. PUMPING LEVEL BELOW LSD n.				DESCRIPTION				
STATIC WATER LEVEL® BELOW LSO n.	FRUM	то						
YIELD IN GALLONS PER MIN.			Na	L06				
HOW TESTED TIME (HR.)								
IF F, SHUTHN PRESS. IN PSI								
GEOLOGICAL SOURCE OF H ₂ O								
CASING DIA In. FROM 11. TO 11.	-							
In. FROM n. TO n.								
CASING TYPE								
PERFORATEO INTERVAL								
ft. TO ft.	i i							
ft. TOft.				·				
PERFORATION DESC.								
PUMP SIZE (HP.) TYPE								
DATE WELL COMPLETED								
BY WHOM LIC								
SOURCE OF INFO! WELL APPROP.								
DRILLER OWNER USGS SCS								
OTHER								
HAS WELL LOCATION BEEN VERIFIED PES								
BY WHOM I OS BOTTLE AGENCY MBMG								
DATE VERIFIED _ 8-19-82								
MEAS. POINT ABOVE LSD ft. DATE								
TOTAL DEPTH BELOW LSD ft		-						
PUMPING LEVEL BELOW LSD T. B-19-82								
YIELO IN GPM								
WATER TEMP. C								
SPECIFIC COND. at 25 C								
MBMG FILE NUMBER								
DNR FILE NUMBER WELL FORM NUMBER								
MBMG WQ LAB. NUMBER				SKETCH MAP	,			
SYS 2000 NUMBER		- L	1211 at		d 200 yord			
OTHER:	3							
				of Hous	2			
REMARKS:			1 Tox	11	A			
			11 5400	На	TN			
				not	, ,			
SE - ELOWING					C-1			
*F = FLOWING MBMG Form 182 (9/79)				Well				

COUNTY CHSCHDE T.	_				
O 1 11 N. LONG.		U	лтм	_ N	Ε
TOWN SUBDIVISION				BLOCK	LOT
OWNER'S NAME SCHOTT		A	DORESS		
	PHONE NU	MBER_		YEAR_	
ALT. LAND SURF. AT WELL MSL 4210 11.			LITHOLO	IGIC LOG	
TOTAL DEPTH BELOW LSD /25 m.		L (FT.)	LITTOLO		
PUMPING LEVEL BELOW LSD ft.		ТО		DESCRIPTION	
STATIC WATER LEVEL® BELOW LSD ft.					
YIELD IN GALLONS PER MIN.					
HOW TESTED TIME (HR.)					
IF F, SHUT-IN PRESS. IN PSI					
GEOLOGICAL SOURCE OF H,O					
2					
CASING DIA In, FROM					
In. FROM ft. TO ft.					
CASING TYPE					
PERFORATED INTERVAL ft. TO ft.					
n. TOn.	1 1				
ft. TOft.	1 1				-
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED					
HOW DRILLED					
BY WHOM LIC					
WELL USE		1			
SOURCE OF INFO: WELL APPROP.					
DRILLER OWNER USQS SCS					
OTHER:					
HAS WELL LOCATION BEEN VERIFIED YES					
BY WHOM J. OShorne AGENCY MBMG					
DATE VERIFIED 8-19-82					
MEAS. POINT ABOVE LSD 3./9 ft. DATE					
TOTAL DEPTH BELOW LSD ft					
PUMPING LEVEL BELOW LSD					
SWL · BELOW LSD 108.86 m. 8-19-82					
YIELD IN OPM					
WATER TEMP. °C					
SPECIFIC COND. at 25°C 355 8-19-82					
M8MG FILE NUMBER					
ONR FILE NUMBER					
WELL FORM NUMBER					
MBMQ WQ LAB. NUMBER			, 1	KETCH MAP	/
SYS 2000 NUMBER		Wes	+ 51/20	of road i	ust off of
OTHER:			1/0/	e Crk. Bri	doe at
REMARKS:		cre	amery	bldg.	
397 @ 30.6°C					//
					C-2
AS - SI OWING				House 1	dies el
*F * FLOWING MBMG Form 182 (9/79)				. 6 - 11	C-2
MUMO FUTTH TOX 18/18/			N	Bowill of the	9*

COUNTY CASCADE T. L	18 Aors	R	4 CONW SEC. TRACT AAAS
AT N. LONG	ı н w.		UTM N E
			BLOCK LOT
TOWN SUBDIVISION	٠		BLOCK SO.
DWNER'S NAME DONALD A. YURG	e K		ADDRESS STOCKETT MT. 59480
	PHONE	IUMBER	YEAR
ALT. LAND SURF. AT WELL MSL 4075	1.		LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD 131 M	1	AL (FT.)	
PUMPING LEVEL BELOW LSD 125 M		то	DESCRIPTION
STATIC WATER LEVEL BELOW LSD 26	L		
VIELD IN GALLONS PER MIN.	0	4	TOP SOIL
HOW TESTED BAJER TIME (HR.) 1	4	30	
IE E SHUTAN PRESS, IN PSI	-	10.0	AND SANDSTONE BONKERS
DEOLOGICAL SOURCE OF HO SANDY SHALE	30	38	DARK BROWN-GREY SHALE
LOOTENA & MODALON	38	141	HARd-GRAY ling SHAIR
	. 41	43	LIGHT GRAY SHATE
CASING DIA (Sin. FROM _ O R. TO _ 65	n. 43	48	MAROOM SHAIR
In. FROM ft. TO f	r. <u>40</u>	149	Red Rock
CASING TYPE STEEL	49	58	Red ROCK AND SHALE
PERFORATED INTERVAL 3/ 11. TO	n. 58	76	VERIGATED LIMEY SANDROCK
n. TO 1	rt.		2 GPM 65-70
PERFORATION DESC	12/6	81	
PERFORATION DESC. 15" WUTS	81	184	
PUMP SIZE (HP.) TYPE	87	90	
PUMP SIZE (HP.) TYPE	90	96	VERIGATED SHALE
HOW ORILLED CABLE	96	102	VERIGATED SAND ROCK
HOW ORILLED CABLE BY WHOM PAT BYRNE LIC. 3/8	102	105	Red Rock
WELL USE STOCK - Domestic	105	120	GRAY-GREEN SONDY SHAIRROS
SOURCE OF INFO: WELL APPROP.	120	126	
DRILLER OWNER USGS SCS	126	129	GOAL
OTHER	129	131	DARK GRAY SANDY SHALE
HAS WELL LOCATION BEEN VERIFIED Yes		1	
ON WHOM 1/20 MAN MOOREAGENCY MBMG			
DATE VERIFIED 6/21/82	_		
MEAS, POINT ABOVE LSD ft. DATE			
TOTAL DEPTH BELOW LSD ft	_	1	
PUMPING LEVEL BELOW LSDft	18,0	FK	73949
SWL BELOW 150 7.70 m. 3. 21/8"	2		1
VIELD IN GPM 7.2 (4)21/82	2		
WATER TEMP. C /2./ (/)1/82			
SPECIFIC COND. At 25°C 677 WILL BA	2		
MBMO FILE NUMBER			
DNR FILE NUMBER			
WELL FORM NUMBER			
MBMG WG LAB. NUMBER			SKETCH MAP
SYS 2000 NUMBER			Tour PTT
OTHERI	1.1.7/	4	
	1		
REMARKS		؍ لتا:	(227)
nemarka)			
			75
			C-3
·F - FLOWING			11 VI - York Proces
MBMG Form 182 (9/79)		W.P.	THE CONCH)

SPRING

COUNTY CASCADE T.		R	4 Oorw	sec. <u>/4</u>	TRACT ACBD
LAT N. LONG	w.	·	лтм	N	ε
TOWN SUBDIVISION .					
OWNER'S NAME RICK YUREK		^	DORESS _	FUANS RT	STOCKETT
	PHONE N	UMBER_		YEAR	
ALT. LAND SURF. AT WELL MSL 3880 M.			LITHOLO	OGIC LOG	
TOTAL DEPTH BELOW LSD	INTERV	AL (FT.)			
PUMPING LEVEL BELOW LSD	FROM	то		DESCRIPTION	
STATIC WATER LEVEL® BELOW LSO ft.					
YIELD IN GALLONS PER MIN.					
HOW TESTED TIME (HR.)					
IF F, SHUT-IN PRESS. IN PS1					
GEOLOGICAL SOURCE OF H20 KOOTENAI					
CASING DIA In. FROM					
In, FROM ft. TO ft.					
CASING TYPE					
PERFORATED INTERVAL ft. TO ft.					
ft. TO ft.					
n. Toft.	-				
PERFORATION DESC.	-				
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED					
HOW DRILLED					
BY WHOM LIC					
WELL USE					
SOURCE OF INFO: WELL APPROP.					
DRILLER OWNER USGS SCS					
OTHER:					
HAS WELL LOCATION BEEN VERIFIED YES					
BY WHOM HENDAN MONE AGENCY MBMG					
DATE VERIFIED 6/0//82					
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSD ft					
PUMPING LEVEL BELOW LSO ft.	-				
SWL* BELOW LSD					
YIELD IN GPM	-				
WATER TEMP. C					
SPECIFIC COND. at 25 C 272 (72//82				· · · · · · · · · · · · · · · · · · ·	
MBMG FILE NUMBER		-			
DNR FILE NUMBER					
WELL FORM NUMBER			٧6.	METCH MAR	
MBMG WQ LAB. NUMBER		4	YURP USE	KETCH MAP	
SYS 2000 NUMBER			1 / 100 la	MC MINE!	
OTHER:	7.7		1 /13	17	
REMARKS: PRIVER Two Wells BODA 17 T CANTIC MAD WENT DRY. WILL ON HOCK UP TO TATHERS WELL AT 18N-4E-11-AAAC		N Ser	ST O ST	(3)	
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MBMG Form 182 (9/79)			A		

COUNTY CASCADE T. 18						
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TOWN SUBDIVISION _				6L	оск	LOT
OWNER'S NAME RAIPH SINGLE						
	PHONE N	IUM BE R			YEAR	
ALT. LAND SURF. AT WELL MSL 3910 R.			LITH	LOGIC LOG		
TOTAL DEPTH BELOW LSD 55 M.	INTERV			/codic cod		
		ТО		DESC	RIPTION	
STATIC WATER LEVEL BELOW LSD 25 1.	PROM	10				
YIELD IN GALLONS PER MIN.			1			
HOW TESTED TIME (HR.)						
IF F, SHUT-IN PRESS. IN PSI						
GEOLOGICAL SOURCE OF H20 - ON CONE						
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CASING DIA 6 In. FROM R. TO R.						
CASING TYPE PLASTIC						
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PERFORATED INTERVAL ft. TO ft.						
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n. TO nt.						
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DATE WELL COMPLETED						
BY WHOM LIC						
WELL USE DOMESTIC + STOCK						
SOURCE OF INFO! WELL APPROP.						
DRILLER OWNER X USQS SCS						
OTHER!						
omen						
HAS WELL LOCATION BEEN VERIFIED YEL						
BY WHOM HERMAN R STORCAGENCY MA.MG						
DATE VERIFIED 6/04/02						
MEAS. POINT ABOVE LSD ft. DATE						
TOTAL DEPTH BELOW LSD ft						
PUMPING LEVEL BELOW LSD ft.						
SWL* BELOW LSD n.						
VIELD IN GPM 3 6/21/82						
WATER TEMP. C 9.20 6/04/82						
SPECIFIC COND. at 25°C 528 621/82						
MBMG FILE NUMBER						
ONR FILE NUMBER						
WELL FORM NUMBER						
MBMQ WQ LAB. NUMBER				SKETCH MA		
SYS 2000 NUMBER		₩ ↑	<u> </u>	1 To S	outeT	Γ
OTHERI	3					
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TOWN SUBDIVISION BLOCK LOT OWNERS FOR RESERVENCE LOT OWNER'S NAME FILE OWNER'S NAME FOR SUBDIVISION BLOCK LOT OWNER'S NAME FILE OWNER SUBDIVISION BLOCK LOT OWNER'S NAME FILE OWNER SUBDIVISION BERN RELOW LSO THE COLOR OWNER SUBDIVISION BERN RIN. HOW TESTED TO THE CHR. TO THE CASHING DIA, E. In. FROM IT. TO IT. TO THE CHR. TO THE CASHING DIA, E. In. FROM IT. TO IT. TO THE CHR. TO THE CASHING DIA, E. IN. FROM IT. TO THE CASHING DIA, E. IN. FROM IT. TO THE CASHING TOWNER SUBDIVISION BEEN WHOM FIRE ALL STOCKS. TO THE CHR. TO THE CASHING DIA SUBDIVISION BEEN VERIFIED LOCK. WELL USE DESCRIPTION WELL APPROXIMATE ABENCY PLANTAGE. WELL TO THE REMOVE SO THE	COUNTY CASCADE T. /	& Dors	R. 4 60	w sec. 28	_ TRACT CADE
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POMPING LEVEL BELOW LSD TRATIC WATER LEVEL'S BELOW LSD YIELD IN GALLONS PER MIN. HOW TESTED. TIME (HR.) IF F, SHUTTIN PRESS. IN PSI GEOLOGICAL SOURCE OF H ₂ O AND JENE JENE CASING DIA. LID. FROM TI. TO TI. TI. TI. TO TI. TI. TO TI. TI. TO TI. TI. TI. TO TI. TI. TI. TO TI. TI. TI. TI. TI. TI. TI. T		PHONE NUM	BER	YI	EAR
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HOW TESTED TIME (MR.) IF F, SHUTHN PRESS. IN PSI GEOLOGICAL SOURCE OF H ₂ O END STONE CASING DIA. & IR. FROM TI. TO TI. III. FROM TI. TO TI. III. FROM TI. TO TI. TI. TO	STATIC WATER LEVEL BELOW LSD 39' 16	T ROM			
IF F, SHUTIN PRESS. IN PSI GEOLOGICAL SOURCE OF H ₂ O SENSTONE K BATENAI CASING DIA. In. FROM. II. TO II. III. FROM. III. TO III. III. TO III. R. TO III.	YIELD IN GALLONS PER MIN.				
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WELL USE DEMONTACE STOCK SOURCE OF INFO; WELL APPROP. DRILLER OWNER USGS SCS OTHER: HAS WELL LOCATION BEEN VERIFIED YCS BY WHOM HEADMAN Moore AGENCY MB.MG. OATE VERIFIED (6/07/82 MEAS, POINT ABOVE LSD ft. PUMPING LEVEL BELOW LSD ft. SWL* BELOW LSD ft. SWL* BELOW LSD ft. SWL* BELOW LSD ft. SPECIFIC COND. at 25°C MBMO FILE NUMBER DNR FILE NUMBER MBMG WQ LAB. NUMBER SYS 2000 NUMBER OTHER: REMARKS: F* FLOWING C-6					
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DRILLER OWNER USGS SCS OTHER: HAS WELL LOCATION BEEN VERIFIED YCL BY WHOM HOM MONE AGENCY MRMC OATE VERIFIED (4/07/82 MEAS, POINT ABOVE LSD 11. DATE TOTAL OEPTH BELOW LSD 11. SWL* BELOW LSD 12.33 4/07/82 WHELD IN OPM WATER TEMP. C 12.33 4/07/82 MBMG FILE NUMBER ONR FILE NUMBER WELL FORM NUMBER WELL FORM NUMBER SYS 2000 NUMBER OTHER: REMARKSI F * FLOWING PARAJA C - 6	WELLUSE DOMESTICASTOCK				
OTHER: HAS WELL LOCATION BEEN VERIFIED WHOM HEAMAN Moore Agency M.B.M.C. OATE VERIFIED WEAS. POINT ABOVE LSD TOTAL OEPTH BELOW LSD TH. PUMPING LEVEL BELOW LSD TR. VIELD IN OPM WATER TEMP.°C SPECIFIC COND. At 25°C MBMG FILE NUMBER DNR FILE NUMBER WELL FORM NUMBER WELL FORM NUMBER OTHER: REMARKSI FOR FLOWING C-6					
HAS WELL LOCATION BEEN VERIFIED YC BY WHOM					
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PUMPING LEVEL BELOW LSD TH. SWL* BELOW LSD TH. YIELD IN OPM WATER TEMP. C SPECIFIC COND. at 25°C MBMG FILE NUMBER DNR FILE NUMBER WELL FORM NUMBER WELL FORM NUMBER SYS 2000 NUMBER OTHER: REMARKS: SHETCH MAP C-6					
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REMARKS: N F * FLOWING C-6			F GREAT	ماله	
REMARKS: N		20	*	26)	
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TOWN SUBDIVISION				BLOCK	LOT
OWNER'S NAME MATT FRISNEGG	er		ADDRESS	STUCKE	=TT
	PHONE N	UMBER		YE	ZAR
3695			LITHO	LOGIC LOG	
ALT. LAND SURF. AT WELL MSL TOTAL DEPTH BELOW LSD PUMPING LEVEL BELOW LSD UNUSED 11.	INTERV	AL (FT.)	LITTAG	LOGIC LOG	
DUMPING LEVEL RELOW LSD UNUSED to				DESCRIPT	ION
STATIC WATER LEVEL BELOW LSO 29.48 M.	FROM	ТО			
YIELD IN GALLONS PER MIN.					
HOW TESTED TIME (HR.)					
IF F, SHUTHN PRESS. IN PSI					
DEDLOGICAL SOURCE OF H20 SAND STONE					
MORPINEN					
CASING DIA . In. FROM					
CASING TYPE STEEL 1. TO 1. TO 1.					
PERFORATED INTERVAL					
ft. TO ft					
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED					
HOW DRILLED					
8Y WHOM LIC					
WELL USE UNUSED					
SOURCE OF INFO! WELL APPROP.					
DRILLER OWNER USGS SCS					
OTHER:					
HAS WELL LOCATION BEEN VERIFIED Yes	-				
BY WHOM HERMAN MOORE AGENCY MBMG					
DATE VERIFIED 6/02/82					
/ '					
MEAS, POINT ABOVE LSD ft. DATE					
PUMPING LEVEL BELOW LSD R. 6/02/82 SWL BELOW LSD 24.48 R. 6/02/82					
YIELD IN GPM					
WATER TEMP. C					
SPECIFIC COND. at 25 C					
MBMO FILE NUMBER					
ONR FILE NUMBER					
WELL FORM NUMBER			L		
MBMO WQ LAB. NUMBER				SKETCH MAP	
SYS 2000 NUMBER		↑ -	7 BUGP		
OTHER!	6		1	1250	FROM LINCTETT
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lettell water				1	0 8
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N. CONG.					
TOWN SUBDIVISION _				BLOCK _	LOT
OWNER'S NAME ANNA DOLENA				0-4/15	Tackatt
OWNER'S NAME / W/V A DOTE NA			ADDRESS	130× 61 3	OCKETT
	PHONE N	JMBER.		YEA	R
ALT. LAND SURF. AT WELL MSL 3800 ft.			LITHO	LOGIC LOG	
TOTAL DEPTH BELOW LSD 35 m.	INTERV	AL (FT.)		reducted	
PUMPING LEVEL BELOW LSD ft.	FROM	TO		DESCRIPTIO	N
STATIC WATER LEVEL BELOW LSO ft.	FROM	10			
YIELD IN GALLONS PER MIN.					
HOW TESTED TIME (HR.)					
IF F, SHUT-IN PRESS. IN PSI					
GEOLOGICAL SOURCE OF H20 C/A7 Allunum					
Allyvium					
CASING DIA. 2 In. FROM ft. TO ft.					
In. FROM ft. TO ft.					
CASING TYPE			<u> </u>		
PERFORATED INTERVALft. TOft.					
ft. TOft. PERFORATION DESC					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED					
HOW DRILLED					
BY WHOMLIC					
WELLUSE DOMESTIC + STOCK					
SOURCE OF INFO: WELL APPROP.					
DRILLER OWNER _X USGS SCS					
OTHER:					
k .					
HAS WELL LOCATION BEEN VERIFIED CS					
BY WHOM HERMAN MOORE AGENCY MRMG					
DATE VERIFIED 6/04/82					
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSD ft					
SWL BELOW LSD #. 4. 4/82					
YIELD IN GPM					
WATER TEMP. C 5.70 6/04/82					
SPECIFIC COND. at 25°C 983 604/12					
MBMG FILE NUMBER					
DNR FILE NUMBER					
WELL FORM NUMBER					
MBMG WQ LAB. NUMBER		7	- PUMP	SKETCH MAP	
SYS 2000 NUMBER		1	1		
OTHER:	H-7+	- 1	10		
		- N S	Toche TI	750	c
REMARKS:	لللللا			-0-1 1. 13 141	from Stockett
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		cotton	ruso O) ()	
*F * FLOWING	_	Real		4 4	C-8
MBMG Form 182 (9/79)					

COUNTY CASCADE T. 18		R	5 (EDW SEC. / TRACT & CAC
LAT N. LONG	w.		UTM N E
TOWN SUBDIVISION _			
OWNER'S NAME Felix MENGHIA	vi		ADDRESS BOX 62 STOCKETT
	PHONE	NUMBER _	YEAR
ALT. LAND SURF. AT WELL MSL 3818 ft.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD 32 M. PUMPING LEVEL BELOW LSD n.		AL (FT.)	DESCRIPTION
STATIC WATER LEVEL BELOW LSD 20 11.			
YIELD IN GALLONS PER MIN.	0	25	CLAY loose Rock
HOW TESTED TIME (HR.)	25	30	Loose SANDSTONE
IF F, SHUT-IN PRESS. IN PSI	30	132	CLAY
GEOLOGICAL SOURCE OF H20 All wallen			
CASING DIA & In. FROM n. TO n.			
in. FROM ft. TO ft.			
CASING TYPE STEEL			
PERFORATED INTERVAL _ 15 ft. TO _ 10 ft.			
n. TO n.			
ft. TO ft.	-		
PERFORATION DESC.			
PUMP SIZE (HP.) TYPE JET PUMP			
DATE WELL COMPLETED 9/1/179			
HOW DRILLED SIBIC LIC. FY			
BY WHOM LIC. 64			
WELLUSE DOMESTIC			
SOURCE OF INFO WELL APPROP.			
DRILLER OWNER USGS SCS			
OTHER:			
OTHER			
HAS WELL LOCATION BEEN VERIFIED YES			
BY WHOM HERMAN MOOLEAGENCY MBMG			
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MEAS. POINT ABOVE LSD ft. DATE			
TOTAL DEPTH BELOW LSD ft			
PUMPING LEVEL BELOW LSO ft.			
SWL BELOW LSO n			
YIELD IN GPM			
WATER TEMP. C 8.5 (#4/82 SPECIFIC COND. at 25°C 828 (104/82			
MBMQ FILE NUMBER			
ONR FILE NUMBER			
WELL FORM NUMBER			
MBMG WQ LAB. NUMBER		1	STOLL & METCH MAD
SYS 2000 NUMBER	>		
OTHER:	7-		2
		N	8
REMARKS:	الململم		1.75m.; m Siellett
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			£ 191
AS A SI OWING			C-9
*F * FLOWING			Nat -11

COUNTY CASCADE T.					
LAT N. LONG	w.		UTM	N	Ε
TOWN SUBDIVISION	٧			BLOCK	LOT
OWNER'S NAME MARY BOTH JAC	OBES		ADDRESS _	BeIT 1	hT
	_ PHONE N	UMBER_		Y0	ZAR
ALT. LAND SURF. AT WELL MSL 4240 M	t.			OGIC LOG	
				DESCRIPT	ION
STATIC WATER LEVEL® BELOW LSD YIELD IN GALLONS PER MIN.	t.	то			
YIELD IN GALLONS PER MIN					
HOW TESTED TIME (HR.)					
IF F, SHUT-IN PRESS. IN PSI					
GEOLOGICAL SOURCE OF HO CHAP TONC					
GEOLOGICAL SOURCE OF H20 CAINP (TONE KOOTENA)					
CASING DIA. E In. FROM ft. TO ft	1.				
In. FROM ft. TO f	١.				
CASING TYPE					
PERFORATED INTERVAL ft. TO ft.	t.				
ft. TO f	١.				
ft. TO f	2.				
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE SUBMENSAGIE					
DATE WELL COMPLETED					
HOW DRILLED					
BY WHOM LIC					
WELLUSE DOMESTIC + STOCK					
SOURCE OF INFO: WELL APPROP.					
DRILLER OWNER K USGS SCS					
OTHER:					
HAS WELL LOCATION BEEN VERIFIED YES					
BY WHOM HERMAN MOORE AGENCY MOME			<u></u>		
DATE VERIFIED					
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSD ft					
PUMPING LEVEL BELOW LSD ft					
SWL* BELOW LSD ft					
YIELD IN GPM					
WATER TEMP. C (-9 (-107/82)					
SPECIFIC COND. at 25 C 588 6/07/82	-				
MBMG FILE NUMBER					
ONR FILE NUMBER					
WELL FORM NUMBER					
MBMQ WQ LAB. NUMBER				W Coule c	
SYS 2000 NUMBER		:: 7	1/03/	,	12
OTHER:	//	- A		A	
OSMA DVS				17	8
REMARKS1	Linking Link				0.5
				MIM	CCAVE! Y!!
				0	Oleve
*F = FLOWING			P	7	C-10
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OUNTY SHECHOE T.	Nors	R	EOW	SEC.	TRACT EDAC
AT N. LONG,	w.	UT	гм	N	Ε
OWN SUBDIVISION				BLOCK _	LOT
		UMBER			`
LT. LAND SURF. AT WELL MSL 4380 11.			LITHOL	ogic Log	
OTAL DEPTH BELOW LSD 75 n.		AL (FT.)		DESCRIPTION	
UMPING LEVEL BELOW LSD n.	FROM	TO		DESCRIPTION	•
TATIC WATER LEVEL BELOW LSD ft.			11/0	L09	
TELD IN GALLONS PER MIN.					
OW TESTED TIME (HR.)					
F F, SHUT-IN PRESS. IN PSI					
FORMATION					
ASING DIA In. FROM					
In. FROM ft. TO ft.					
ASING TYPE					
ERFORATED INTERVAL					
ft. TO ft	1				
ERFORATION DESC.					
UMP SIZE (HP.) TYPE					
DATE WELL COMPLETED					
OW ORILLEO					
Y WHOM LIC					
VELL USE					
OURCE OF INFO: WELL APPROP.					
DRILLER OWNER USGS SCS					
OTHER:					
V .					
AS WELL LOCATION BEEN VERIFIED					
BY WHOM TO OS BOLLE AGENCY 14616	-				
DATE VERIFIED 1-19-82					
MEAS, POINT ABOVE LSO ft. DATE					
TOTAL DEPTH BELOW LSO ft					
PUMPING LEVEL BELOW LSO ft.					
SWL BELOW LSD 23.32 n. 8-19-82					
YIELD IN GPM					
NATER TEMP. C					
SPECIFIC COND. at 25°C 506 8-19-83	2				
MBMG FILE NUMBER					
ONR FILE NUMBER					
YELL FORM NUMBER				SKETCH MAP	
MBMG WQ LAB. NUMBER			, a).		
SYS 2000 NUMBER			TTO	xkeH	1
OTHER:	31-		1 5+0	x ke	11
REMARKS: 5, C, 393 (2) 13,7°C	المامام				
= 505.6 C. 75°C					
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			ľ	torice 1	C-11
•F = FLOWING MBMG Form 182 (9/79)				0	

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COUNTY PRECATE T.		R	TEDIN SEC. TRACT CADE
O 1 11 O 1			UTM N E
TOWN SUBDIVISION _			BLOCKLOT
OWNER'S NAME - DO TENTE STORY OF STORY			ADDRESS SAND LOULTE /
EDUCEL JULY DAY OF THE			
	PHONEN	IUMBER.	YEAR
ALT. LAND SURF. AT WELL MSL 3650 11.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD ft.	INTERV	AL (FT.)	
PUMPING LEVEL BELOW LSD	FROM	то	DESCRIPTION
YIELD IN GALLONS PER MIN.	1	5	SINLSTONE
HOW TESTED E TIME (HR.)	5	7	LLAY
IF F, SHUT-IN PRESS. IN PSI		12	SANT - NE
GEOLOGICAL SOURCE OF H20 M34/ 30		/5	CURIEFO: E
-		= '	<u> </u>
	1	-1	5101, -3NE
CASING DIA. 4/2 In. FROM ft. TO ft.	- '	45	: FITFO: Y
in. FROM ft. TO ft.		43	CANLS-ONE
CASING TYPE	- 5	65	SURLEROSK
PERFORATED INTERVAL 96 tt. TO 147 tt.	. , , , , ,	22	- MESTONE
ft. TO ft.	-,,=	132	SANTSTONA
ft. TO ft.	7.7	177	C. P. EROSK
PERFORATION DESC.		179	EXMESTONE
PUMP SIZE (HP.) TYPE	' -)	253	SURLENDIN
DATE WELL COMPLETED 2-5-67	13	267	TIME & -DISE BARK - SLE XAC-1:
HOW DRILLED FORKE	757	285	LIMESTONE
BY WHOM ENTOPICY CENTER LONG LIC. ST	335	296	260174
WELL USE STOLE	- 36	303	LINEZTINE
SOURCE OF INFO: WELL APPROP.	: 23	5,21	2/1/
DRILLER OWNER USGS SCS	307		I ASSTONE FERONN CANT TONE
OTHER:	336	33.8	CRUTT
	338	305	LIMESTONE EXCLUSION TAND
BY WHOM W. BENJENN AGENCY MEN :			
DATE VERIFIED 2/3/95			
MEAS. POINT ABOVE LSD ft. DATE	Top	MA1. +	3302
TOTAL DEPTH BELOW LSD			
PUMPING LEVEL BELOW LSD ft			
SWL® BELOW LSD			
YIELD IN GPM			
WATER TEMP. C			
SPECIFIC COND. at 25 C			
MBMG FILE NUMBER			
ONR FILE NUMBER			
WELL FORM NUMBER		ĺ	
MBMG WG LAB. NUMBER			J SKETCH MAP
SYS 2000 NUMBER			1-
OTHER:			at 2
TOTAL CONTRACTOR OF THE PARTY O			
REMARKS: SEMEN-EL FININE			
CAC NG FROM 15 -2 355'			Aspen
2 INER 11/2 NOT 1- 1 30166			25) (8
DE FINE DE OFF IS ISIE			
•F • FLOWING			C-12
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			RUAD

COUNTY CASCADE T.		R	4 BOW	SEC. 12	TRACT ADDC
0 1 H 0 0 LONG			UTM	N	Ε
TOWN SUBDIVISION	ON			BLOCK	LOT
OWNER'S NAME GORDON & VERA M	LINDT		ADDRESS	Box 62-A.	SAND Coulee
	PHONE	NUM DER		YEAF	
ALT. LAND SURF. AT WELL MISL 3420	ft.			LOGIC LOG	
TOTAL DEPTH BELOW LSD /36	0		1	DESCRIPTION	
PUMPING LEVEL BELOW LSD STATIC WATER LEVEL® BELOW LSD YIELD IN GALLONS PER MIN. 15	n. FROM				
YIELD IN GALLONS PER MIN. 15	_ 0			SILT	
HOW TESTED BAILER TIME (HR.)	170	120	GLACIA	1 DRITT	
IF F. SHUTHN PRESS, IN PSI	120	1/36	WATER	BEARING	SANDSTONE
GEOLOGICAL SOURCE OF H.O. SANDSTOAKS					
GEOLOGICAL SOURCE OF H20 SANDSTOAKE	_				
CASING DIA & In. FROM O M. TO 120	n				
In. FROM ft. TO	i				
CASING TYPE STEEL					
PERFORATED INTERVAL ft. TO					
п. то					
п. то	1				
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED JAN. 28, 1974					
HOW DRILLED CABLE					
BY WHOM THOMAS FRANKLIN LIC. 84					
WELLUSE DOMESTIC - LAWN + GARden	v				
SOURCE OF INFO: WELL APPROP.					
DRILLER OWNER USQS SCS		1			
OTHER:					
HAS WELL LOCATION BEEN VERIFIED YES	_	1			
BY WHOM HERMAN MORRE AGENCY MBMS	6	+			
DATE VERIFIED 6/09/82		-	-		
MEAS. POINT ABOVE LSO ft. DATE		-			
TOTAL DEPTH BELOW LSD ft					
PUMPING LEVEL BELOW LSD ft	_				
SWL* BELOW LSD ft					
YIELD IN GPM	2				
WATER TEMP. C /3 6/09/8	2				
SPECIFIC COND. at 25°C 2339 409/1	7	-			
MBMG FILE NUMBER		-			
ONR FILE NUMBER					
WELL FORM NUMBER		1		AMERICA MAR	
MBMG WQ LAB. NUMBER		T 1	, 2	JACTON WAS	
SYS 2000 NUMBER		1:0	3,	111	
OTHER:	- 12		34	tin	
		1	1	Er.	
REMARKS:			/	10	
	_		/	/.	
	_	(227)) /	11164	C-13
•F • FLOWING	_	(-)		9 In 5	W. L.
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O 1 H ONG.	w.		UTM	N	Ε
TOWN SUBDIVISION _				BLOCK _	LOT
OWNER'S NAME JOHN PEJKO			ADDRESS	STOCKET	T MT. 59480
	PHONE	NUMBER			R
ALT. LAND SURF. AT WELL MSL 3482 M.				LOGIC LOG	
TOTAL DEPTH BELOW LSD 70 H.	INTERV	/AL (FT.)			
PUMPING LEVEL BELOW LSD 70 ft.	FROM	то		DESCRIPTIO	N
STATIC WATER LEVEL® BELOW LSO 415 ft. VIELD IN GALLONS PER MIN. 50	>	2	TOP	Soil	
HOW TESTED TIME (HR.)	2.			JN SAND	SIT
	16	47			ANDY CIAY
GEOLOGICAL SOURCE OF H20 MORE SON	47	58	BROKE	N SANDSTO	WE + WATER
GEOLOGICAL SOURCE OF H ₂ O	58	70		GREEN S	
CASING DIA. 68 In. FROM C N. TO 50 N.					
59/6in. FROM 49 tt. TO 70 tt.					
CASING TYPE					
PERFORATED INTERVAL ft. TO ft.					
ft. TO ft.					
ft. TO ft.					
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE SUB.		ļ			
DATE WELL COMPLETED 2/26/1978		<u> </u>			
HOW DRILLED CABIC BY WHOM PAT BYRNE LIC. 318		ļ		·	
BY WHOM PAT BYRNE LIC. 318		-	-		
WELLUSE Domestic (INWAGARDEN)		-	-		
SOURCE OF INFO: WELL APPROP.					
DRILLER OWNER USGS SCS					
OTHER:			-		
\/a/			-		
HAS WELL LOCATION BEEN VERIFIED			+		
BY WHOM HELMIAN MODRE AGENCY M.B. M.G.	-	-			
DATE VERIFIED 6/04/82		-	-		
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSO		-			
PUMPING LEVEL BELOW LSD					
SWL* BELOW LSD					
WATER TEMP. C 7.9 404/82					
WATER TEMP.°C 7.9 404/82 SPECIFIC COND. et 25°C 222 404/82 MBMG FILE NUMBER					
MBMG FILE NUMBER			1		
ONR FILE NUMBER					
WELL FORM NUMBER					
MBMG WQ LAB. NUMBER			TO SPADES	BRETCH MAP	
SYS 2000 NUMBER		4	7	6	17)
OTHER:	-12-	1	091	17	
		-			I TEAL 2
REMARKS:					t
		/			
as a st owner					C-14
*F * FLOWING MBMG Form 182 (9/79)			5	NO Cosice IT	centerville
MIDING FUITH 104 (0)101			10 70	NU Costee 16) LENI

COUNTY	2 gars	Ř	1 CONW	SEC. /2	TRACT DBAA
0 1 H 0 1	м. w.		UTM	N	€
TOWNSUBDIVISION _				BLOCK _	LOT
OWNER'S NAME RICHERD KAJALA			ADDRESS	SANI JOU	11/2
	PHONE N	NUMBER		YEA	R
ALT. LAND SURF. AT WELL MSL 3440 11.			LITHO	LOGIC LOG	
TOTAL DEPTH BELOW LSD 58 M.	INTERV	AL (FT.)			
PUMPING LEVEL BELOW LSD	FROM	то		DESCRIPTION	٧
STATIC WATER LEVEL* BELOW LSD ft.	0	60		AL DRIFT	7
YIELD IN GALLONS PER MIN.		125		KY LAY	5 /~ F
HOW TESTED PAILED TIME (HR.) 3				4 KIE	
IF F, SHUT-IN PRESS. IN PSI		158		5.7000	
GEOLOGICAL SOURCE OF H20 MADISON	147	1-0	21716	7. 0 W.F	
L/46312~6	-				
CASING DIA 2 In. FROM 0 N. TO 47 R.	101	1761 -	3293		
CASING DIA In. FROM R. TO R.	City	7771	30/2		
In. FROM N. TO N. CASING TYPE JECN (20 40/44)	-				
PERFORATED INTERVAL ft. TO ft.		 			
ft. TO ft.					
ft.					
PERFORATION DESC.		-			
PUMP SIZE (HP.) TYPE		-			
DATE WELL COMPLETED 7-3-64		-			
HOW DRILLED CARLE TOOL		-			
BY WHOM THOMAS FRANKLIN LIC	-				
	-	-			
SOURCE OF INFO! WELL APPROP SCS		1			
OTHER:					
HAS WELL LOCATION BEEN VERIFIED YES					
BY WHOM W. BENTAMIN AGENCY (BMG					
DATE VERIFIED 6-9-82					
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSD 1t.					
PUMPING LEVEL BELOW LSD			1		
SWL BELOW LSD 1010 n. 6/4/22					
YIELD IN GPM					
WATER TEMP.°C /3.1 6/1/82					
SPECIFIC COND. at 25°C (1/2 6/9/72					
MBMQ FILE NUMBER					
ONR FILE NUMBER					
WELL FORM NUMBER					
MBMQ WQ LAB. NUMBER		- 11	J	SKETCH MAP	
SYS 2000 NUMBER	,	111 /		WELL	
OTHERI	12-			一丁 ブイル	- 7
				1	
REMARKS: 5 1-331 9 /95°C		Ш			
478 9 13.1°C					
					C-15
*F = FLOWING				14	
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COUNTY IN LONG. W. UTM N E BLOCK LOT ADDRESS SINCLUSIVE II PHONE NUMBER YEAR ALT. LAND SUBF. AT WELL MSL TOTAL DEFTH BELOW LSO PHONE NUMBER YEAR ALT. LAND SUBF. AT WELL MSL TOTAL DEFTH BELOW LSO PHONE STATIC WATER LEVEL 'BELOW LSO TOTAL DEFTH BELOW LSO TOTAL DEFTH BELOW LSO TOTAL DEFTH BELOW LSO TOTAL DESTA THE (HR.) TO TO TO TO STATIC WATER LEVEL 'BELOW LSO TO TO SO'C COUNTY CASING DIA. IN FROM O IT, TO SO TO TO SO TO SO'C SUBFICION CASING DIA. TO T	1	J	OFFICE I	
SUBDIVISION BLOCK LOT OWNER'S NAME	COUNTY	_Nors	R	ENW SEC. TRACT
ADDRESS SAIN. JURISLE MAN JURISLE SAIN. JURI	0 1 H 0 1			UTM R E
ALT. LAND SURF. AT WELL MSL TOTAL DEPTH BELOW LSD PUMPING LEVEL BELOW LSD TOTAL DEPTH BELOW LSD PUMPING LEVEL BELOW LSD TATOR WATER LEVEL' BELOW LSD TATOR WATER LEVEL' BELOW LSD TOTAL DEPTH BELOW LSD	TOWN SUBDIVISION _			BLOCKLOT
ALT LAND SURFAT WELL MSL TOTAL DEPTH BELOW ISD THE TOTAL DEPTH INTO THE TOTAL THE TOTAL DEPTH BELOW ISD TOTAL	OWNER'S NAME EVELYINA LYMAIN			ADDRESS SAME LOUISE 11
ALT LAND SURFAT WELL MSL TOTAL DEPTH BELOW ISD THE TOTAL DEPTH INTO THE TOTAL THE TOTAL DEPTH BELOW ISD TOTAL				
TOTAL DEPTH BELOW LSD		PHONE N	IUMBER .	YEAR
GEOLOGICAL SOURCE OF H,O JUPAS S.K. CUMULE. CASING DIA. III. FROM D. R. TO S. R. LILII. FROM D. R. TO S. R. LILII. FROM D. R. TO S. R. CASING TYPE PERFORATEO INTERVAL 126 R. TO 13 R. R. TO R. R. TO R. R. TO R. PUMP SIZE (HP). TYPE DATE WELL COMPLETED D. TYPE DATE WELL COMPLETED D. T. T. D. T. WELL USE D. T. T. D. T. BY WHOM D. T. T. T. T. ORILLER. OWNER D. USOS SCS OTHER: BY WHOM D. T. T. T. T. T. BY WHOM D. T. T. T. T. T. BY WHOM D. T. T. T. T. T. T. BY WHOM D. T. T. T. T. T. T. BY WHOM D. T. T. T. T. T. T. T. BY WHOM D. T. T. T. T. T. T. T. T. BY WHOM D. T. T. T. T. T. T. T. T. BY WHOM D. T. T. T. T. T. T. T. T. BY WHOM D. T. T. T. T. T. T. T. T. T. BY WHOM D. T. T. T. T. T. T. T. T. T. BY WHOM D. T. T. T. T. T. T. T. T. T. BY WHOM D. T. T. T. T. T. T. T. T. T. BY WHOM D. T. BY WHOM D. T. BY WHOM D. T. BY WHOM D. T.	ALT. LAND SURF. AT WELL MSL			LITHOLOGIC LOG
GEOLOGICAL SOURCE OF H, O Suppassive undile CASING DIA. In. FROM DR. TO SS. R. CASING DIA. In. FROM DR. TO SS. R. CASING TYPE PERFORATEO INTERVAL 126 R. TO 131 R. R. TO R. R. TO R. PUMP SIZE (HP). TYPE DATE WELL COMPLETED 12 S. WELL USE 10 S. M. D. C. WELL USE 10 S. S. OTHER! BY WHOM 10 SEC. VERIFIED 15 SOURCE OF INFO. WELL APPROP. ORILLER OWNER 10 USOS SCS. OTHER! BY WHOM 10 SC SCS. OTHER STORY BELOW LSD R. PUMPING LEVEL BELOW LSD R. WELL DOAD STORY BELOW LSD R. PUMPING LEVEL BEL	TOTAL DEPTH BELOW LSD	INTERV	AL (FT.)	
GEOLOGICAL SOURCE OF H, O Suppassive undile CASING DIA. In. FROM DR. TO SS. R. CASING DIA. In. FROM DR. TO SS. R. CASING TYPE PERFORATEO INTERVAL 126 R. TO 131 R. R. TO R. R. TO R. PUMP SIZE (HP). TYPE DATE WELL COMPLETED 12 S. WELL USE 10 S. M. D. C. WELL USE 10 S. S. OTHER! BY WHOM 10 SEC. VERIFIED 15 SOURCE OF INFO. WELL APPROP. ORILLER OWNER 10 USOS SCS. OTHER! BY WHOM 10 SC SCS. OTHER STORY BELOW LSD R. PUMPING LEVEL BELOW LSD R. WELL DOAD STORY BELOW LSD R. PUMPING LEVEL BEL	PUMPING LEVEL BELOW LSD	FROM	то	DESCRIPTION
GEOLOGICAL SOURCE OF H, O Suppassive undile CASING DIA. In. FROM DR. TO SS. R. CASING DIA. In. FROM DR. TO SS. R. CASING TYPE PERFORATEO INTERVAL 126 R. TO 131 R. R. TO R. R. TO R. PUMP SIZE (HP). TYPE DATE WELL COMPLETED 12 S. WELL USE 10 S. M. D. C. WELL USE 10 S. S. OTHER! BY WHOM 10 SEC. VERIFIED 15 SOURCE OF INFO. WELL APPROP. ORILLER OWNER 10 USOS SCS. OTHER! BY WHOM 10 SC SCS. OTHER STORY BELOW LSD R. PUMPING LEVEL BELOW LSD R. WELL DOAD STORY BELOW LSD R. PUMPING LEVEL BEL	STATIC WATER LEVEL* BELOW LSO ft.		7.0	
GEOLOGICAL SOURCE OF H, O Suppassive undile CASING DIA. In. FROM DR. TO SS. R. CASING DIA. In. FROM DR. TO SS. R. CASING TYPE PERFORATEO INTERVAL 126 R. TO 131 R. R. TO R. R. TO R. PUMP SIZE (HP). TYPE DATE WELL COMPLETED 12 S. WELL USE 10 S. M. D. C. WELL USE 10 S. S. OTHER! BY WHOM 10 SEC. VERIFIED 15 SOURCE OF INFO. WELL APPROP. ORILLER OWNER 10 USOS SCS. OTHER! BY WHOM 10 SC SCS. OTHER STORY BELOW LSD R. PUMPING LEVEL BELOW LSD R. WELL DOAD STORY BELOW LSD R. PUMPING LEVEL BEL	YIELD IN GALLONS PER MIN.	70		
GEOLOGICAL SOURCE OF H, O Suppassive undile CASING DIA. In. FROM DR. TO SS. R. CASING DIA. In. FROM DR. TO SS. R. CASING TYPE PERFORATEO INTERVAL 126 R. TO 131 R. R. TO R. R. TO R. PUMP SIZE (HP). TYPE DATE WELL COMPLETED 12 S. WELL USE 10 S. M. D. C. WELL USE 10 S. S. OTHER! BY WHOM 10 SEC. VERIFIED 15 SOURCE OF INFO. WELL APPROP. ORILLER OWNER 10 USOS SCS. OTHER! BY WHOM 10 SC SCS. OTHER STORY BELOW LSD R. PUMPING LEVEL BELOW LSD R. WELL DOAD STORY BELOW LSD R. PUMPING LEVEL BEL	HOW TESTED TIME (HR.)	20		
CASING DIA. In. FROM O N. TO SE N. CASING DIA. In. FROM O N. TO SE N. CASING TYPE PERFORATED INTERVAL 126 N. TO 131 N. N. TO N. N. TO N. N. TO N. PERFORATION DESC. PUMP SIZE (NP). DATE WELL COMPLETED O 2-2-6-6 BY WHOM 10-1-1-1-1-1-1-1 SOURCE OF INFO. WELL APPROP. ORILLER OWNER USOS SCS OTHER: BY WHOM 16-1-1-1-1 BY WHOM 16-1-1-1-1 SOURCE OF INFO. WELL APPROP. OTHER: BY WHOM 16-1-1-1-1 SOURCE OF INFO. WELL APPROP. OTHER: BY WHOM 16-1-1-1-1 SOURCE OF INFO. WELL APPROP. OTHER: BY WHOM 16-1-1-1-1 SOURCE OF INFO. WELL APPROP. OTHER: BY WHOM 16-1-1-1-1 SOURCE OF INFO. WELL APPROP. OTHER: BY WHOM 16-1-1-1-1 SOURCE OF INFO. WELL APPROP. OTHER: BY WHOM 16-1-1-1 SOURCE OF INFO. WELL APPROP. OTHER: BY WHOM 16-1-1-1 SOURCE OF INFO. WELL APPROP. OTHER: OTHER: SOURCE OF INFO. WELL APPROP. OTHER: OT		30		
CASING DIA. In. FROM OR. TO SERVE TO STATE OF THE CONTROL OF THE C	GEOLOGICAL SOURCE OF H20			SANE STONE
CASING DIA	Jurassic unclas.			
CASING TYPE PERFORATED INTERVAL TI. TO TI.				
CASING TYPE PERFORATEO INTERVAL 126 ft. TO 3 ft. ft. TO ft. ft. TO ft. PERFORATION DESC. PUMP SIZE (HP). DATE WELL COMPLETED 5 5 6 HOW DRILLED 5 2 7 8 HOW DRILLED 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	CASING DIA In. FROM ft. TO ft.			
PERFORATED INTERVAL 126 ft. TO 3 ft. ft. TO ft. ft. TO ft. PERFORATION DESC. PUMP SIZE (HP) DATE WELL COMPLETED DATE WELL COMPLETED SOURCE OF INFO; WELL APPROP. ORILLER OWNER USOS SCS OTHER: HAS WELL LOCATION BEEN VERIFIED DATE VERIFIED 4 7 82 MEAS, POINT ABOVE LSO TOTAL DEPTH BELOW LSO TOTAL DEPTH BELOW LSO TOTAL DEPTH BELOW LSO TI. PUMPING LEVEL BELOW LSO TI. SWL*BELOW LSO TOWNER TEMP, C SPECIFIC COND. at 2°S C DATE VERIFIED WEAL NUMBER WELL FORM NUMBER WELL FORM NUMBER TOTAL DEPTH WEBER OTHER: MEMORY FILE NUMBER OTHER: REMARKS: 1/1 1/17 SI 7/17 S	12-in. FROM 29 ft. TO 12- ft.	7/	126	
# F. TO # ft. # ft. TO # ft.		124	1 = 7	
## TO		126	151	SANESTONE
PERFORATION DESC. PUMP SIZE (HP) TYPE DATE WELL COMPLETED 6 6 6 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				
PUMP SIZE (HP) DATE WELL COMPLETED DESCRIPTION BY WHOM FOR CYPTIS LIC. 135" WELL USE SOURCE OF INFOL WELL APPROP. DRILLER: HAS WELL LOCATION BEEN VERIFIED BY WHOM DESCRIPTION AGENCY MEM'S BY WHOM DESCRIPTION AGENCY				
DATE WELL COMPLETED 10-10-67 HOW DRILLED 20 R N DRIZE WHOM POPULIES LIC. 1355 WELL USE 20 SURCE OF INFO! WELL APPROP. DRILLER OWNER USOS SCS OTHER: HAS WELL LOCATION BEEN VERIFIED 15 S BY WHOM 10-10-10 N AGENCY MONE DATE VERIFIED 2-9-82 MEAS. POINT ABOVE LSD 11. DATE TOTAL DEPTH BELOW LSD 11. DYMPING LEVEL BELOW LSD 11. SWL. BELOW LSD 11. SWL. BELOW LSD 11. WATER TEMP. C 115 (1/12) MBMO FILE NUMBER ONA FILE NUMBER ONA FILE NUMBER ONA FILE NUMBER OTHER! REMARKS: 211 2-115 S1-10 S1 TOY NO ST 15 S1 TOY				
HOW DRILLED SCAN DATE BY WHOM FOR CYLINE LIC. 135" WELL USE OWNER USOS SCS OTHER: HAS WELL LOCATION BEEN VERIFIED BY WHOM DISTRIP A AGENCY MAN	PUMP SIZE (HP.) TYPE			
BY WHOM WELL USE SOURCE OF INFO; WELL APPROP. ORILLER OWNER USOS SCS OTHER: HAS WELL LOCATION BEEN VERIFIED MEAS, POINT ABOVE LSD TOTAL DEPTH BELOW LSD	DATE WELL COMPLETED 6			
WELL USE SOURCE OF INFO; WELL APPROP. ORILLER OWNER USOS SCS OTHER: HAS WELL LOCATION BEEN VERIFIED BY WHOM DEPTH BELOW LSD MEAS, POINT ABOVE LSD TOTAL DEPTH BELOW LSD TOTAL DE	HOW DRILLED LORD LICE 135			
SOURCE OF INFO! WELL APPROP. DRILLER OWNER USOS SCS OTHER! HAS WELL LOCATION BEEN VERIFIED BY WHOM MALE METERN AGENCY MENOS DATE VERIFIED 6-9-82 MEAS. POINT ABOVE LSD TOTAL DEPTH BELOW LSD FUMPING LEVEL BELOW LSD TI. SWL* BELOW LSD TI. SWL* BELOW LSD TI. WATER TEMP. C SPECIFIC COND. at 25°C DONR FILE NUMBER DNR FILE NUMBER WELL FORM NUMBER OTHER! REMARKS: 1/1 1/17 SI-10 SYS 2000 NUMBER OTHER! REMARKS: 1/1 1/17 SI-10 STEEL SIGNAL SOLUTION FF = FLOWING MBMG Form 182 (979)	BY WHOM AND LICE.			
DRILLER OWNER USOS SCS OTHER: HAS WELL LOCATION BEEN VERIFIED 15 3 BY WHOM 16 15 15 17 17 17 18 AGENCY 16 15 5 BY WHOM 26 15 17 17 18 AGENCY 16 15 5 DATE VERIFIED 6-9-82 MEAS, POINT ABOVE LSD 16. PUMPING LEVEL BELOW LSD 16. SWL* BELOW LSD 16. SWL* BELOW LSD 17. SWL* BELOW LSD 17. SWL* BELOW LSD 17. WATER TEMP. C 125 17 17 17 17 17 17 17 17 17 17 17 17 17				
OTHER: HAS WELL LOCATION BEEN VERIFIED /5 5 BY WHOM A.C. MICH M. AGENCY MENCS DATE VERIFIED C-7-BZ MEAS, POINT ABOVE LSD ft. TOTAL DEPTH BELOW LSD ft. PUMPING LEVEL BELOW LSD ft. SWL* BELOW LSD ft. SWL* BELOW LSD ft. SPECIFIC COND. at 25°C 2207 (/ 4/F2) MBMG FILE NUMBER ONA FILE NUMBER WELL FORM NUMBER SYS 2000 NUMBER OTHER: REMARKS: 11 1 1217 C1-F-C2 *F - FLOWING MBMG Form 182 (9/79)				
HAS WELL LOCATION BEEN VERIFIED /5 5 BY WHOM / 1/2 1/2 1/2 A AGENCY MCM S DATE VERIFIED _6 -9 - 82 MEAS, POINT ABOVE LSD 11. DATE TOTAL DEPTH BELOW LSD 11. SWL* BELOW LSD 11. SWL* BELOW LSD 11. SWL* BELOW LSD 11. SPECIFIC COND. at 25°C 25 2/9/72 SPECIFIC COND. at 25°C 22 07 2/9/72 MBMG FILE NUMBER WELL FORM NUMBER WELL FORM NUMBER SYS 2000 NUMBER OTHER: REMARKS: _2/1 2/15 5°C *F = FLOWING MBMG Form 182 (9/79) *F = FLOWING MBMG Form 182 (9/79)				
BY WHOM DEPTH BELOW LSD AGENCY LEGS MEAS, POINT ABOVE LSD II. DATE TOTAL DEPTH BELOW LSD II. PUMPING LEVEL BELOW LSD II. YIELD IN OPM WATER TEMP. C SPECIFIC COND. at 25°C MBMO FILE NUMBER ONR FILE NUMBER WELL FORM NUMBER SYS 2000 NUMBER OTHER: REMARKS: 1/1 1/217 × 5/2 × 2 770 Y/0 @ /Z, 5°2 *F - FLOWING MBMG Form 192 (9/79)	OTREK:			
BY WHOM DEPTH BELOW LSD AGENCY LEGS MEAS, POINT ABOVE LSD II. DATE TOTAL DEPTH BELOW LSD II. PUMPING LEVEL BELOW LSD II. YIELD IN OPM WATER TEMP. C SPECIFIC COND. at 25°C MBMO FILE NUMBER ONR FILE NUMBER WELL FORM NUMBER SYS 2000 NUMBER OTHER: REMARKS: 1/1 1/217 × 5/2 × 2 770 Y/0 @ /Z, 5°2 *F - FLOWING MBMG Form 192 (9/79)	HAS WELL LOCATION REEN VERIFIED 1/5 5			
DATE VERIFIED 4-9-82 MEAS. POINT ABOVE LSD 11. TOTAL DEPTH BELOW LSD 11. PUMPING LEVEL BELOW LSD 11. SWL* BELOW LSD 11. YIELD IN OPM WATER TEMP. C 725 (/4/72 SPECIFIC COND. at 2°C 2207 (/4/82 MBMO FILE NUMBER DNA FILE NUMBER WELL FORM NUMBER SYS 2000 NUMBER OTHER: REMARKS: 1/1 1/217 5/7 5/7 / TO Y/O @ /Z.5°C *F - FLOWING MBMG Form 192 (9/79)	BY WHOM I GO WELL A ACENCY MERY G			
MEAS. POINT ABOVE LSD TOTAL DEPTH BELOW LSD PUMPING LEVEL BELOW LSD #t. SWL* BELOW LSD YIELD IN GPM WATER TEMP. C SPECIFIC COND. at 25°C MBMG FILE NUMBER WELL FORM NUMBER MBMG WQ LAB. NUMBER SYS 2000 NUMBER OTHER: PEMARKS: 1/1/1/1/5°C FF *FLOWING MBMG Form 192 (9/79)	DATE VEGICIED 6-9-82			
TOTAL DEPTH BELOW LSD ft. PUMPING LEVEL BELOW LSD ft. SWL* BELOW LSD ft. SWL* BELOW LSD ft. YIELD IN GPM WATER TEMP. C SPECIFIC COND. at 25 C DAY 17 D MBMG FILE NUMBER WELL FORM NUMBER WELL FORM NUMBER SYS 2000 NUMBER OTHER: REMARKS: 1/1 1/11/15 S/ - / - / - / - / - / - / - / - / - /				
PUMPING LEVEL BELOW LSD SWL* BELOW LSD TI. YIELD IN GPM WATER TEMP.°C SPECIFIC COND. at 25°C ANDRO FILE NUMBER ONA FILE NUMBER WELL FORM NUMBER SYS 2000 NUMBER OTHER: REMARKS: 1/1/1/25°C TO Y 10 & 12.5°C *F = FLOWING MBMG Form 192 (9/79)				
SWL* BELOW LSD YIELD IN GPM WATER TEMP. C SPECIFIC COND. at 25 C DOT 1/12 MBMG FILE NUMBER WELL FORM NUMBER WELL FORM NUMBER SYS 2000 NUMBER OTHER: REMARKS: 1/1 1/217 S 2 -				
WATER TEMP. C SPECIFIC COND. at 25°C SPECIFIC COND. at 25°C MBMG FILE NUMBER DNR FILE NUMBER WELL FORM NUMBER MBMG WQ LAB. NUMBER SYS 2000 NUMBER OTHER: REMARKS: 1/1 1/217 21 - 1/2 *F * FLOWING MBMG Form 192 (9/79)				
WATER TEMP. C SPECIFIC COND. at 25 C 2207 (/ 4/82) MBMG FILE NUMBER DNR FILE NUMBER WELL FORM NUMBER SYS 2000 NUMBER OTHER: REMARKS: 1/1 1/217 21 - 1 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2	VIELD IN ON			
SPECIFIC COND. at 25°C 2207 (1982) MBMO FILE NUMBER ONR FILE NUMBER WELL FORM NUMBER WELL FORM NUMBER SYS 2000 NUMBER OTHER: REMARKS: 1/1 1/317 & SI - A - 20 170 × 10 & 12.5°C WBMG Form 192 (9/79)	WATER TEMP. C 725 6/4/72			
MBMO FILE NUMBER WELL FORM NUMBER MBMO WQ LAB. NUMBER SYS 2000 NUMBER OTHER: REMARKS: 1/1 1/217 × 5/2 / 1/217	SPECIFIC COND. at 25°C 2207 6/4/82			
ONR FILE NUMBER WELL FORM NUMBER MBMG WQ LAB. NUMBER SYS 2000 NUMBER OTHER: REMARKS: 1/1 1/217 × 5/- /- /- /- /- /- /- /- /- /- /- /- /- /				
WELL FORM NUMBER MBMG WQ LAB. NUMBER SYS 2000 NUMBER OTHER: REMARKS: 1/1 1/217 2/1 - /2 - /2 - /2 - /2 - /2 - /2 - /2				
SYS 2000 NUMBER OTHER: REMARKS: 1/1 1/217 2 2/ - / - 2/ - 2/ - 2/ - 2/ - 2/ - 2/				
SYS 2000 NUMBER OTHER: REMARKS: 1/1: 1/2:17 < 5/- /- /- /- /- /- /- /- /- /- /- /- /- /	MBMQ WQ LAB. NUMBER			SKETCH MAP
REMARKS: 1/1 1/217 2 5/7 / 2 5				
REMARKS: 1/1 1/12/7 2/7 2/7 2/7 2/7 2/7 2/7 2/7 2/7 2/7		12-	Ji.	-17-
770 × 10 8 /2.5° C •F • FLOWING MBMG Form 182 (9/79)			14:	
770 × 10 @ /Z.5°C •F = FLOWING MBMG Form 182 (9/79)	REMARKS: LETT - 1921 C SITE F			
*F = FLOWING MBMG Form 182 (9/79)	J-L 33439.7,5°C			/
MBMG Form 182 (9/79)	170 × 10 @ 12.5°C			/ /
MBMG Form 182 (9/79)				C-16
MBMG Form 182 (9/79)				
	MBMG Form 182 (8//9)		- 100	Wals Com

COUNTY LAGGADE T.	12 Aus	R.	4/ Ne or W	sec. 13	TRACT AAAD
o I H N. LONG.	1 "W.		UTM	N	Ε
TOWN SUBDIVISI	ON			STAR RT.	LOT
OWNER'S NAME MIKE KAVULLA			ADDRESS	ind (asse	e MT.
	PHONE	NUMBER		YEAR	
ALT. LAND SURF. AT WELL MSL 3440	**		LITHOL	ogic Log	
TOTAL DEPTH BELOW LSD /70		/AL (FT.)			
PUMPING LEVEL BELOW LSD STATIC WATER LEVEL® BELOW LSD YIELD IN GALLONS PER MIN.	n. FROM	то	1	DESCRIPTION	
STATIC WATER LEVEL BELOW LSD 36	ft.				
VIELD IN GALLONS PER MIN. 25	0	140	Clay	= 6000001	
		170	Lime	STONE	
IF F. SHUT-IN PRESS. IN PSI		1	-		
IF F, SHUT-IN PRESS. IN PSI GEOLOGICAL SOURCE OF H ₂ O MAJION					
7 0 120	+21	17/1/2	+.125 h		
CASING DIA. Z In. FROM ft. TO	n.	1110	10130		
	т				
CASING TYPE IFE ON					
PERFORATED INTERVAL ft. TO					
n. TO		1			
ft. TO	- ft-	-			
PERFORATION DESC.	_				
PUMP SIZE (HP.) TYPE	_				
DATE WELL COMPLETED (2/20/55		+			
HOW DRILLED CHURN DEUI	_	-	+		
BY WHOM _ E. L. FlooD LIC	-	-			
WELLUSE Domestic		-			
SOURCE OF INFO: WELL APPROP.		-	-		
DRILLER OWNER USOS SCS					
OTHERI	_				
HAS WELL LOCATION BEEN VERIFIED YES	_				
BY WHOM HERMAN MOURPAGENCY MB/	16	-			
DATE VERIFIED 6/10/82					
MEAS. POINT ABOVE LSD 11. DATE	Ε				
TOTAL DEPTH BELOW LSD ft					
PUMPING LEVEL BELOW LSD ft.					
SWL* BELOW LSO ft					
WATER TEMP. C 12.2 6/10/5 SPECIFIC COND. at 25°C //69 6/10/8	2				
SPECIFIC COND # 25°C 1/69 6/10/8	2				
MBMG FILE NUMBER					
ONR FILE NUMBER					
WELL FORM NUMBER					
MBMQ WQ LAB. NUMBER		A	1/117	SKETCH MAP	
SYS 2000 NUMBER		1	1		
OTHER:		ال الله	15	: RICH	
O			11		
REMARKS:		111		110. 10-	
The state of the s				JE vell	
		/		HILL HUI	1300
		10 200	0	HIJ.	EJEN C-17
·F - FLOWING		1. 7	1116		6-17
MRMC Form 192 (9/79)					

COUNTY CASCASE T. 15	La ors	R	4 arw	SEC. /3	TRACT 4183
o 1 11 0 1	n w.		UTM	_ N	E
TOWN SUBDIVISION _				BLOCK	LOT
OWNER'S NAME Reprely nch			ADDRESS	AND COULE	30x 7/
				YEAR	
ALT. LAND SURF. AT WELL MSL 3430 11.			LITHOLOG	GIC LOG	
TOTAL DEPTH BELOW LSO 168 #.	INTERV	AL (FT.)			
PUMPING LEVEL BELOW LSD	FROM	TO		DESCRIPTION	
STATIC WATER LEVEL® BELOW LSOft.		,,,			
YIELD IN GALLONS PER MIN.			No	106	
HOW TESTED TIME (HR.)					
IF F, SHUT-IN PRESS. IN PSI			Roperted	to be in	Madian.
GEOLOGICAL SOURCE OF H20 MADISON LIMESTAL			Loneste	one - owne	r
MADISON LIMOSTANA				·	
CASING DIA In. FROM ft. TO ft.					
In. FROM ft. TO ft. CASING TYPE					
PERFORATED INTERVAL ft. TO ft.					
#. 10 ft.					
ft. TO ft.					
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED Over 30 goars aga					
HOW DRILLED					
BY WHOM LIC					
WELL USE					
SOURCE OF INFO: WELL APPROP.					
DRILLER OWNER USGS SCS					
OTHER:					
HAS WELL LOCATION BEEN VERIFIED Tes					
BY WHOM T. OSSOCIATE AGENCY MBNG					
DATE VERIFIED 6 18.82					
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSD ft					
PUMPING LEVEL BELOW LSD ft.					
SWL BELOW LSD 10178 H. 6-16-82					
YIELD IN GPM					
WATER TEMP. °C					
SPECIFIC COND. at 25°C 700. 6.16 82					
MBMG FILE NUMBER					
DNR FILE NUMBER					
WELL FORM NUMBER					
MBMG WQ LAB. NUMBER _ \$2 90504			54	KETCH MAP	(
SYS 2000 NUMBER		111	1	/	Trong
OTHER:	/3-		7		/.
Course totals - 1 - 1.4.					\ '
REMARKS: Cours september quelity	لبلبلنا	النا	N		
(" is & acceptance) has alway new				/ -	
sed.					
*F = FLOWING				10 House	C-18
MBMG Form 182 (9/79)					
MICHIGA WITH THE WITH					

COUNTY CASCADE T. /		4 (E) OF W	sec. 13	TRACT AADB
0 1 H 0 1 LAT N. LONG	и W.	UTM	N	ε 3
TOWN SUBDIVISION .			BLOCK	LOT
OWNER'S NAME GEORGE SOHA				
OWNER'S NAME SEONGE SOMA		ADDRESS _	JANI COU	/ 6.6
	PHONE NUMBER		YEAR _	
ALT. LAND SURF. AT WELL MSL 3440 11.		LITHOL	OGIC LOG	
TOTAL DEPTH BELOW LSO 2/2 n.	INTERVAL (FT.)		
STATIC WATER LEVEL BELOW LSD 60 12	FROM TO		DESCRIPTION	
YIELD IN GALLONS PER MIN.		+		
HOW TESTED TIME (HR.)		-		
IF F, SHUTHN PRESS. IN PSI				
GEOLOGICAL SOURCE OF H20				
CASING DIA ft. TO ft.				
ft. TO ft.				
CASING TYPE		-		
PERFORATED INTERVAL ft. TO ft.				
ft. TO ft.				
ft. TO ft.				
PERFORATION DESC.				
PUMP SIZE (HP.) TYPE				
DATE WELL COMPLETED		-		
HOW DRILLED				
BY WHOM LIC				
WELL USE				
SOURCE OF INFO! WELL APPROP.				
DRILLER OWNER USGS SCS				
OTHER: MITE EAVUILA		-		
HAS WELL LOCATION BEEN VERIFIED Yes				
BY WHOM HEREM POOR & AGENCY MRMG				
DATE VERIFIED _//0/92		 		
		-		
MEAS. POINT ABOVE LSD ft. DATE				
TOTAL DEPTH BELOW LSO ft.				
PUMPING LEVEL BELOW LSD ft.		-		
SWL* BELOW LSO ft		-		
YIELD IN GPM // //// / //// /// //// ///// ////////				
WATER TEMP. C 12 6/0/82				
SPECIFIC COND. at 25 C 6/9 6/10/82				
MBMG FILE NUMBER		1		
DNR FILE NUMBER				
WELL FORM NUMBER		1RNY-7	SKETCH MAP	
MBMG WQ LAB. NUMBERSYS 2000 NUMBER	A CHARLES	TIE/		
OTHERI		11:		
VIII.		100		
REMARKS:		7/1	16 FIEUM	m2 (
	(2.	1/1/	Elevini	.)
	^	111	VA	
	in ee	2	NUMBER !	C-19
*F - FLOWING	500		HA LEVEN	
MBMG Form 182 (9/79)	6.00	-	4	No. 110
			1 1- CURL	N. W.

COUNTY CASCADE T.	_	R	4 FORW	sec. <u>13</u>	_ TRACT AADD
0 1 11 0 1 LAT N. LONG	w.		UTM	N	ε
TOWN SUBDIVISION				BLOCK .	LOT
OWNER'S NAME CHARLES ENTS!	7/NG6	er.	ADDRESS _	SAND COU	1) lecMT.
	PHONE !	NUMBER		YE	AR
ALT, LAND SURF, AT WELL MSL 3440 ft.			LITHO	LOGIC LOG	
ALT. LAND SURF. AT WELL MSL 170 ft. TOTAL DEPTH BELOW LSD 185 ft.	———	/AL (FT.)		LOGIC LOG	
PUMPING LEVEL BELOW LSD /50 ft.			-	DESCRIPTION	DN .
STATIC WATER LEVEL* BELOW LSD 121 11.	FROM	TO			
VIELD IN GALLONS PER MIN.	0	10	TOP	(0//	
HOW TESTED TIME (HR.) 2	10	30		SANDY (1)	AY LONG
IF F, SHUT-IN PRESS. IN PSI	30				IATER WITH
GEOLOGICAL SOURCE OF HO LIME TONE			SOFTY	ellow (1	Au
(PEULEN) MADISON	39	/22	GRAY	SIT	0
	/22			IN SAND	y SiIT
CASING DIA. 20 In. FROM 0 H. TO 43 H.		1.52		IN SANG	
65 in. FROM 43 ft. TO 185 ft.	152	154	7		DSTONE AND
CASING TYPE STEEL	100	757			and water
		157		IN SANG	
PERFORATED INTERVAL ft. TO ft.	11.				
tt. TO tt.				BROWN	
ft. TO ft.					AND WATER
PERFORATION DESC.	1.68				Tone SAND
PUMP SIZE (HP.) TYPE				I AND W	
DATE WELL COMPLETED		-	-	40 GPM.	<i>t)</i>
HOW DRILLEDCABIC			-		
BY WHOM PAT BYRNE LIC. 318		ļ			
WELL USE DOMESTIC		-	ļ		
SOURCE OF INFO: WELL APPROP.					
ORILLER OWNER USGS SCS		ļ	1		
OTHER:					
HAS WELL LOCATION BEEN VERIFIED Yes					
BY WHOM HERMAN MODRE AGENCY MBMG					
DATE VERIFIED 6/08/92					
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSD ft.					
PUMPING LEVEL BELOW LSD ft.					
SWL* BELOW LSD					
YIELD IN GPM /0 6/22/82					
WATER TEMP.°C /0.9 6/8/82					
SPECIFIC COND. at 25°C 620 6/22/92					
		1			
MBMG FILE NUMBER					
ONR FILE NUMBER					
WELL FORM NUMBER				SKETCH MAP	
MBMG WQ LAB. NUMBER		A A	. /		AIN Elevations
SYS 2000 NUMBER		1	well /	(227) 1 GRA	IN CICORTOCO
OTHER:	13-	1	#	The state of the s	1.00
REMARKSI (C STANING ON PLUMBING		N	1/0	NUM	8012
			17	Je Jes	
Sinctimes, old well caved			UN.	/ F	
		Lovie	V	*	- BLALINGTON
*F = FLOWING		creel			MORTHERN
MBMG Form 182 (9/79)				. 1	0 20
MICHAG FORTH TOX 10/10/	ENTSI	MINCES		VTo center.	rile

COUNTY CASCADE T.	2 4		JAN SEE 13 TRACT ALLE
		R	SEC.
• 1 N • 1	11		UTM N E
N. LONG.	w.		
TOWN SUBDIVISION _			BLOCK LOT
			C 10 201 5 - 1/2 T
OWNER'S NAME GEORGE KAYULLA			ADDRESS AND JOICE
			YEAR
	PHONE	UMBER.	
ALT. LAND SURF. AT WELL MISL 3460 ft.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSO 328 M.	INTERV	AL (FT.)	
	FROM	то	DESCRIPTION
STATIC WATER LEVEL® BELOW LSD			
VIELD IN GALLONS PER MIN.	0	. 3	FILL 5 31674 "01:21
HOW TESTED TIME (HR.)			CLAY
	67		SHALE
GEOLOGICAL SOURCE OF H20 MADISON	33		SANDSTONE
LIMESTONE	124	1:4	
	164	24	IMBEDDEI FLINTA 3 H
CASING DIA In. FROM O_ ft. TO 53 ft.	20.	276	INTERMITTENT SANGTINE
in. FROM ft. TO ft.	241	368	E MESTURE WATER
CASING TYPE			
PERFORATED INTERVAL ft. TO ft.			
	~)	MAR	17.136
n. TO ft.		111	
PERFORATION DESC. PUMP SIZE (HP.) / TYPE ELEC. SURMERG.			
PUMP SIZE (HP.) TYPE 22CE. Sugritual	-		
DATE WELL COMPLETED 7-30-60			
BY WHOM LIC			
WELL USE DOMESTIC			
SOURCE OF INFO! WELL APPROP.			
DRILLER OWNER USGS SCS			
OTHERI			
HAS WELL LOCATION BEEN VERIFIED 45			
BY WHOM W. BENGAMIN AGENCY MRMG			
DATE VERIFIED 6-4-82			
MEAS. POINT ABOVE LSD ft. DATE			
TOTAL DEPTH BELOW LSDft			
PUMPING LEVEL BELOW LSD ft.			
swin a deli owi see			
VIELD IN GPM WATER TEMP. C 133°C 133°C 14182 6-4-82		-	
WATER TEMP. C /3.3°C 6-4-82			
SPECIFIC COND. 81 25°C 904 6-4-82			
MBMG FILE NUMBER			
ONR FILE NUMBER	-	-	
WELL FORM NUMBER		1	
MBMG WQ LAB. NUMBER			SKETCH MAP
SYS 2000 NUMBER			Base Vist d' . 'n'
OTHERI			OF SAND LOUGH
22.62.22			01 1/1/20 30000
REMARKS1 = -8.33102/102	للملنا	لبلك	
(8×10.9/33°2			
WI - : LES OF PASING PREVENTEL			
11776 SWL			C-21

.F - FLOWING

T N. LONG			UTM	N	E
WN SUBDIVISION					
NER'S NAME CHUCK PCO					
NER'S NAME					
		NUMBER		YEAR	
T. LAND SURF. AT WELL MSL 3457 11.				LOGIC LOG	
TAL DEPTH BELOW LSD 175 m.		VAL (FT.	2	DESCRIPTION	
	FROM	TO		DESCRIPTION	
ATIC WATER LEVEL® BELOW LSD 130 M.	0	6	Tel	Coll	
ELD IN GALLONS PER MIN.		100		N P11	10° 21 16 1
W TESTED PUMP TIME (HR.)		40			
F, SHUT-IN PRESS. IN PSI	13			moster 2 d	
OLOGICAL SOURCE OF HO -IMPSIONE	79	76	10 1	Acres Acres	
mndion		10	1, 1, 1,	PRONN S. 1	^ '
7	76	126	التواري والمستحدد المواري	1000 50NG	
SING DIA. Z In. FROM n. TO n	. 166	1/2/	1111		
In. FROM ft. TO ft	. 121	1126	1013/5	6804 mo	
SING TYPE STeel	126	1.0		- Arain	
REPORATED INTERVAL ft. TO ft		-	MEIN	xt 108-17	5
ft. TO ft				<u> </u>	
ft. TO ft					
REPORATION DESC.	TOP	MPD.	337/		
MP SIZE (HP.)					
TE WELL COMPLETED					
W DRILLED					
WHOM SOT PURALL LIC.					
ELLUSE Deibestic					
URCE OF INFO WELL APPROP.					
HILLER OWNER USQS SCS					
HER:		1			
Y. C					
WHOM HERMAN MOORE AGENCY MBMG					
WHOM PIETZ MAIN TOUTCE AGENCY PIZZTO					
ATE VERIFIED 6/05/82		-			
EAS. POINT ABOVE LSD ft. DATE		1			
TAL DEPTH BELOW LSDft	-				
MPING LEVEL BELOW LSD 1//					
11. BELOW LSO 82.56 m. 16/05/82	-	+			
ELD IN GPM			†		
ATER TEMP. C		-			
ECIFIC COND. at 25 C 595 6/05/82	-				
BMG FILE NUMBER		-			
R FILE NUMBER		+			
ELL FORM NUMBER			121		
BMQ WQ LAB. NUMBER		-	10h	SKETCH MAP	
'S 2000 NUMBER		4	(22)-		
THER:	13	- 4	0	TNUMBER SEV	eN
		/			
EMARKS:		ے لتا			
		5 (11	\	λ	
		rul.		/ \	
		/			0 22
			1		(- / /
- FLOWING		MSIL			C-22

COUNTY CASCADE T.	9 Nors	A	4 EDIN SEC. 19 TRACT DALA
0 1 H 0 1	H		UTM N E
LAT N. LONG	w.		OTM N E
TOWN SUBDIVISION _			SLOCK LOT
OWNER'S NAME SAND COULEE WATER	UCER	<	AND CASE SANT
OWNER'S NAME	-130/	'	ADDRESS
	PHONE	NUMBER .	YEAR
ALT. LAND SURF. AT WELL MSL 3680 R.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD 210 n.	INTERV	AL (FT.)	
PUMPING LEVEL BELOW LSD n.	FROM	TO	DESCRIPTION
STATIC WATER LEVEL® BELOW LSD ft.			
YIELD IN GALLONS PER MIN.	0	3	SURFACE
HOW TESTED TIME (HR.)		10	SANDS-UNE
IF F, SHUT-IN PRESS. IN PSI	10	/3	SUPLE
GEOLOGICAL SOURCE OF H2O	13	16	SANDSTONE
* KOOTENALTM	16	28	SHALE
	58	52	SAND STUNE
CASING DIA & In. FROM O n. TO 34 n.	52	68	SHALE
in. FROM ft. TO ft.	68	70	SANDSTONE
CASING TYPE IRON	70	76	SHALE
PERFORATED INTERVAL ft. TO ft.	76	81	SANDSTONE
n. TO n.	81	63	SHACE
	83	120	SANDSTONE (YELLOW)
PERFORATION DESC.	120	/33	SUALE
PUMP SIZE (HP.) TYPE	133	192	SANDSTONE (WATER)
DATE WELL COMPLETED 2-15-60	192	195	SHALE ROCK & SINTE
HOW DRILLED	195	198	CIAY
BY WHOM LIC	198		SANDSTONE (WATER)
WELL USE			
SOURCE OF INFO! WELL APPROP.			
ORILLER OWNER USQS SCS			
OTHER:			
OTHER!			
HAS WELL LOCATION BEEN VERIFIED 725			
BY WHOM W. BENJAMIN AGENCY MEMG			
DATE VERIFIED 6-5-82			
MEAS, POINT ABOVE LSD ft. DATE			
TOTAL DEPTH BELOW LSDft.			
PUMPING LEVEL BELOW LSD ft			
SWL* BELOW LSO			
YIELD IN OPM			
WATER TEMP. C			
SPECIFIC COND. M 25 C 8/9 10/5/62	-		
MBMG FILE NUMBER			
ONR FILE NUMBER			
WELL FORM NUMBER			BAETCH MAP
MBMQ WQ LAB. NUMBER	7,1,1,1	Tell .	4.1
5YS 2000 NUMBER			1"
OTHERI	11		· Ivill
REMARKS: WELL #2		1.7	Thursd Stans on in
578 340 @ 22 1° c		/	~/~/
5 1x 10 11, 6 C			/ //
*F * FLOWING			C-23
MBMG Form 182 (9/79)		6	
MOING FORM TOTAL T		L/	

COUNTY CASCALE			R	4 CEMW	sec. <u>14</u>	TRACT DADO
0 1 H N. LONG	0 1	w.	1	UTM	_ N	Ε
TOWN SUBDI	IVISION _				BLOCK _	LOT
OWNER'S NAME SAND COULEE WA						
OWNER'S NAME	2/	100,00	<u> </u>	ADDRESS	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
		PHONE N	IUMBER_		YEA	R
ALT. LAND SURF. AT WELL MSL 368				LITHOLO	GIC LOG	
TOTAL DEPTH BELOW LSD 210		INTERV	AL (FT.)			
PUMPING LEVEL BELOW LSD	m.	FROM	то		DESCRIPTIO	N
STATIC WATER LEVEL BELOW LSD	D 44	0	8	TOP	<	
YIELD IN GALLONS PER MIN. 60 6			27			· (WATER)
HOW TESTED BALER TIME (HR.)		27			-ZN GRES	
IF F, SHUT-IN PRESS. IN PSI		40				
GEOLOGICAL SOURCE OF H20 MORRISON		48	48		SANLS"	
E ANDSTON	! E		53		UN SHAL	
4.57		53	68		4 SANKS	
CASING DIA. 8 8 In. FROM n. TO3		38	70		SHALE	
In. FROM ft. TO		70	34		Y SHALE	
CASING TYPE IRON		84	87		BLACK	
PERFORATED INTERVAL ft. TO	ft.	87	120		SANDY S	
10~ε m. το	ft.	120	128		SANDST	
ft. TO		128	135			IMESTONE
PERFORATION DESC.		135	184		50005	
PUMP SIZE (HP.) TYPE		184	187			DNE- JUAL
DATE WELL COMPLETED 10-11-73		187	210	BLAC	K CLAY-	SHACE.
HOW DRILLED LABLE TOOL						
BY WHOM PAT BYRNE LIC.						
WELLUSE SAND COULEE GATER SUI	PRIV					
SOURCE OF INFO: WELL APPROP.						
DRILLER OWNER USGS SCS _						
OTHER: JOUN MITTAL (PRES S.C.W.						
OTHER.						
HAS WELL LOCATION BEEN VERIFIED YES						
BY WHOM W. GENZAN N AGENCY MI	8M6					
DATE VERIFIED 6-5-82						
MEAS. POINT ABOVE LSO ft. C	DATE					
TOTAL DEPTH BELOW LSD						
PUMPING LEVEL BELOW LSD ft						
SWL* BELOW LSD ft.						
YIELD IN GPM						
WATER TEMP. °C						
0						
SPECIFIC COND. at 25 C						
MBMG FILE NUMBER						
ONR FILE NUMBER						
WELL FORM NUMBER				1 .	KETCH MAP	
MBMG WG LAB. NUMBER			1	~		
SYS 2000 NUMBER					3	
OTHER:				ز د <i>د</i>	/	1 - 1 1 1 1 1 5 JE
REMARKSI WELLE !				- Paritie	~ 3	·
			(,	11/1		
*F = FLOWING				/		C-24
M8MG Form 182 (9/79)			1/			
MOMU POIT 102 (9/19)			1			

COUNTY CASCADE T. 1	19 Dors	R. 4 O Or W	SEC. 14	TRACT DCCB
0 N ONG.	. w.	UTM	N	_ ε
TOWN SUBDIVISION			BLOCK	LOT
OWNER'S NAME CHARLES FRANTZI				
	PHONE NUM	IBER	YEAR	
ALT. LAND SURF. AT WELL MSL 3650 M.			LOGIC LOG	
TOTAL DEPTH BELOW LSD M.	INTERVAL	(FT.)		
PUMPING LEVEL BELOW LSD 28 1.	FROM	то	DESCRIPTION	
STATIC WATER LEVEL BELOW LSD M.	10	, , , , ,		A . 14
STATIC WATER LEVEL* BELOW LSD PL YIELD IN GALLONS PER MIN. HOW TESTED EAR PL TIME (HR.)	10-11-	6/04	- GUMEO AN	a [N] 505
HOW TESTED BALLET TIME (HR.)	1125 21	6	lid harles	2
IF F, SHUT-IN PRESS. IN PSI				
GEOLOGICAL SOURCE OF H20 MD.N				
CASING DIA In. FROM n. TO n. TO n.				
in. FROM ft. TO ft.				
CASING TYPE				
PERFORATED INTERVAL ft. TO ft.				
ft. TO ft.				
ft. TO ft.				
PERFORATION DESC.				
PUMP SIZE (HP.) TYPE				
DATE WELL COMPLETED				
HOW DRILLED				
BY WHOM LIC				
WELL USE				
SOURCE OF INFO: WELL APPROP.				
DRILLER OWNER USGS SCS				
OTHER:				
HAS WELL LOCATION BEEN VERIFIED 1/23				
BY WHOM W. BENJAMIN AGENCY MBMG				
DATE VERIFIED 6-3-82				
MEAS, POINT ABOVE LSD ft. DATE				
TOTAL DEPTH BELOW LSDft				
PUMPING LEVEL BELOW LSO ft.				<u> </u>
SWL BELOW LSD				
YIELD IN OPM				
WATER TEMP. C 10.5 6-3-82				
SPECIFIC COND. at 25°C 1047 1-3-87				
MBMG FILE NUMBER				
ONR FILE NUMBER				
WELL FORM NUMBER				
MBMG WQ LAB. NUMBER			SKETCH MAP	
SYS 2000 NUMBER		1 22	102.4	
OTHER:				
	1			11.121
REMARKS: 5-1 329@ 20,5 °C				100 FF
74×10 9 10.5°C		1	. (
			- (C-25
F - FLOWING			,	C-25
MBMG Form 182 (9/79)				

COUNTY <u>CASCADE</u> T. 1		R	& EXW	SEC. 21	TRACT_DCCO
0 1 H 0 1	w.	UT	гм	N	_ ε
TOWN SUBDIVISION				BLOCK	LOT
OWNER'S NAME CHARLES E, MARKE		AC	DORESS _	SAND COUL	EE MT
	BHONE NU	MMPD		YFAR	
247	THORE NO				
ALT. LAND SURF. AT WELL MSL 3830 M. TOTAL DEPTH BELOW LSD ~/50fc M.	INTERVA	L (FT.)	LITHOLO	OGIC LOG	
PUMPING LEVEL BELOW LSD ft.	FROM	ТО		DESCRIPTION	
STATIC WATER LEVEL® BELOW LSOft.					
YIELD IN GALLONS PER MIN.					
HOW TESTED TIME (HR.)					
IF F, SHUT-IN PRESS. IN PSI					
GEOLOGICAL SOURCE OF H2O			1/2		
2			700	206	
CASING DIA In. FROM ft. TO ft.			AVA	ILABLE	
CASING TYPE					
PERFORATED INTERVAL ft. TO ft.					
ft. TO ft.	1				
ft. TO ft.					
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED					
HOW DRILLED					
BY WHOM LIC.					
WELL USE DONESTIC			·		
SOURCE OF INFO: WELL APPROP.					
ORILLER OWNER USQS SCS					
OTHER:					
HAS WELL LOCATION BEEN VERIFIED YES					
BY WHOM W. BENZANIN AGENCY MEMG					
DATE VERIFIED 6-9-82					
MEAS, POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSDft					
PUMPING LEVEL BELOW LSD ft					
SWL* BELOW LSD #.					
YIELD IN GPM					
WATER TEMP. C 13.4 6-4-82					
SPECIFIC COND. at 25°C 9/5 6-4-82					
MBMG FILE NUMBER					
DNR FILE NUMBER					
WELL FORM NUMBER					
MBMG WQ LAB. NUMBER		_ N	٠, ١	SKETCH MAP	
SYS 2000 NUMBER		1	5.2		
OTHER:		- /	120	3	7
		3	2 /2		1
REMARKS: 5-0 331 321.10				INELL	
5.1.69×100 13.4°		~		1 400-6.	
Unia Live No- MINIABIE				hot	D
Will I'm Cerec No. 1.11. C.C.			(
*F = FLOWING			(C-26
MBMG Form 182 (9/79)					

0 1 H 0 1 LAT N. LONG	w.		UTM N E	
TOWN SUBDIVISION			BLOCK	OT _
			<i>z.</i> , ,	
OWNER'S NAME SCROLD SNARTZENB	ERGER	ŧ	ADDRESS STATED ET	-1
	PHONE I	NUMBER .	YEAR	
ALT, LAND SURF. AT WELL MSL 3765 N.			LITHOLOGIC LOG	
TOTAL DEPTH BELOW LSD 248 M.	INTERV	AL (FT.)		
	FROM	ТО	DESCRIPTION	
STATIC WATER LEVEL BELOW LSD 70 M.				
VIELD IN GALLONS PER MIN.	0	1	LOOSE SAND ROCK	
HOW TESTED BAILER TIME (HR.)	7	15	REL SHALE	
IF F, SHUT-IN PRESS. IN PSI	15	22	ZLAY	
GEOLOGICAL SOURCE OF H20	22	25	HAKE SINDSTONE	
2	25	32	REL SURIE	
	32	36	HALD SLNDSTINE	
CASING DIA 8 In. FROM 0 n. TO 14 n.	36	50	RED CHAE	
la FROM # TO #	50	54	GRAY SIALE	
In. FROM ft. TO ft. CASING TYPE STEEL (10 46/Ft)	59	112	HARD SANDSTONE 47	iino.
PERFORATED INTERVAL ft. TO ft.			I GFM WITER	
7 E n. TO n	1/2	135	GRAY SYALE	
7PE~ [ND	135		SOFT SANLSTONE	
		16€	RED SLE.F	
PERFORATION DESC.		120	CLAY M NED W1	a Ali
PUMP SIZE (HP.) TYPE	220	248	MORRISON SANGEON	
DATE WELL COMPLETED 11-12-73	220	210	W/ YIELD OF AFFRIX	
HOW DRILLED CABLE TOOL		-	WAIR - COA. 9 24	- G/
BY WHOM THOMAS B. FRANKLIN LIC. 84			WATE CONT 3 24	C-
WELL USE DOMESTIC	-	-		
SOURCE OF INFO: WELL APPROP.				
DRILLER OWNER USQS SCS				
OTHER:		-		
<i>u</i>		-		
HAS WELL LOCATION BEEN VERIFIED 755	-			
BY WHOM U. BENJAMIN AGENCY MBMG	-	-		
DATE VERIFIED 6-2-82				
MEAS, POINT ABOVE LSD ft. DATE				
TOTAL DEPTH BELOW LSDft.				
PUMPING LEVEL BELOW LSD ft.				
5WL • 8ELOW LSD				
YIELD IN GPM				
WATER TEMP. C				
SPECIFIC COND. at 25 C				
MBMQ FILE NUMBER				
ONR FILE NUMBER				
		1		
WELL FORM NUMBER		1	SKETCH MAP	
MBMQ WQ LAB. NUMBER		F-1 4		
SYS 2000 NUMBER		1.	- 3) SINE.	nure.
OTHER!	+::::::::::::::::::::::::::::::::::::::	1. '		
REMARKS: OVICE NOULDN - MILOW ME	7.1.			
	tankanha		10.1	
TO TAKE SWL			(1)	

COUNTY PER ALE T.	Piñas P	R. 4 (FORW SEC. 23 TRACT 2211	L
		•	
LAT N. LONG	w.	UTM N E	
		BLOCK LOT	
OWNER'S NAME HARYEY LAKS: 30	5	ADDRESS SAINT SULEE, 11.	,
	PHONE NUMBE	RYEAR	_
3/80		LITHOLOGIC LOG	
ALT. LAND SURF. AT WELL MSL 3680 ft. TOTAL DEPTH BELOW LSD 7.00 ft.	INTERVAL (F)		$-\parallel$
	INTERVAL (F		
PUMPING LEVEL BELOW LSD ft.	FROM TO	DESCRIPTION	
			\neg
YIELD IN GALLONS PER MIN.			
HOW TESTED TIME (HR.)			
IF F, SHUT-IN PRESS. IN PS1			
GEOLOGICAL SOURCE OF H2O			
		11 /	
CASING DIA. 2 In. FROM 2 H. TO 20 H.		110 606	
		LIMITAFIE	
In. FROM ft. TO ft.		(I) A COLO	
CASING TYPE			
PERFORATED INTERVALft. TOft.			
ft. TO ft.			-
PERFORATION DESC.			\dashv
PUMP SIZE (HP.) TYPE	-		
DATE WELL COMPLETED			
HOW DRILLED			\dashv
WELL USE LONG STORY			-
SOURCE OF INFO! WELL APPROP.			
DRILLER OWNER USQS SCS			\dashv
OTHER:			
456			
HAS WELL LOCATION BEEN VERIFIED 455			
DATE VERIFIED 6-9-8-			-
MEAS. POINT ABOVE LSD ft. DATE			-1
TOTAL DEPTH BELOW LSD ft.			
PUMPING LEVEL BELOW LSD ft.			
SWL* BELOW LSD ft.			
YIELD IN GPM (4.) (14/8)			
WATER TEMP. C 1912 G1782 SPECIFIC COND. at 25°C 627 61782			
MBMG FILE NUMBER			
ONR FILE NUMBER			\dashv
WELL FORM NUMBER		SKETCH MAP	
MBMQ WQ LAB. NUMBER		12	
SYS 2000 NUMBER			7101
OTHER:		/-)	
REMARKS: 57/ 3348 11,2°C		1	
57 × 09 14 2°C	1		
		HUNTER	
Temp-11.9°C COMPLUTE MATE		C-28	
°F = FLOWING		C-28	

MBMG Form 182 (9/79)

COUNTY CASCACE T. 1		R	·/ E)or W	SEC.	TRACT BEE
AT N. LONG	" W.		UTM	N	E
				BI OCK	LOT
OWN SUBDIVISION					
WNER'S NAME DER OLD SWAA FELDET	2561		ADORESS	1.11 ,31	<i>r</i> · /
	PHONE	NUMBER		YEA!	
LT. LAND SURF. AT WELL MSL 3775 n.			LITHOLO	GIC LOG	
OTAL DEPTH BELOW LSD 586 M.	INTERV	AL (FT.)			
UMPING LEVEL BELOW LSD 586 m.	FROM	то		DESCRIPTION	•
TATIC WATER LEVEL BELOW LSD 515 12	-	-		7	
IELD IN GALLONS PER MIN.	<u>C</u>	5	D-1		
OW TESTED FUMP TIME (HR.) 2	25	-	RED	51.5.8	
F, SHUT-IN PRESS. IN PSI		19		1- GRENN	
EOLOGICAL SOURCE OF HO Turocsic Unity	15			it stay	
Kootena. Fin Jurissic While		24		SIFIE	
E Madison	24	4-7		SINIE	
ASING DIA SAIN. FROM On. TO 25 M.	49	55		SHELL	
in, FROM ft. TO ft.	55	57	KEL	SIALE	
ASING TYPE 2-26 (STELL)	57	45		5.1.E	
ERFORATED INTERVAL ft. TO ft.	75	78	YELLO	~ SANLS.	- ~!
10NE 1. TO 1.	75	147	GREY	SHALE	
THEND TE. TO TE.	147	175	KEL	SHALE	
ERFORATION DESC.	175	178	CREY	SUPLE	
UMP SIZE (HP.) TYPE	178	187	RED	SLICE	
DATE WELL COMPLETED 6-26-75	187	197		SUPLE	
YOW ORLLED ALE ROTARY	197	230	GRE "	5 / NUS-3.	ul- ://- /
NOW ORILLED AIR ROTARY IN WHOM A SEITH MEATEN LIC. 275	230	239		(S:A: <)	
VELLUSE DOMESTIC	239	250		I CANLE	
OURCE OF INFO! WELL APPROP.	250	-115	SAPE	SHALE	
DRILLER OWNER USGS SCS	415	456			4028-1111
	456	515	1/2 : 5	1 . 112 (1/1. 2)	SON . 1. A
THER:	515	586	50110	1011111	· NE RE JAN
4.6	3/3	050	100011	ALEAN STE	NO "AMFLE
AS WELL LOCATION BEEN VERIFIED 465		1	100000		515-5861
WHOM W. RENTAMIN AGENCY MBMG	-	1	1	-	3 2 00
DATE VERIFIED 6-2-82	10 1	M	3.17		
MEAS. POINT ABOVE LSD R. DATE	fled-	TIAD	12//		
OTAL DEPTH BELOW LSD ft	-	-			
UMPING LEVEL BELOW LSD ft					
WL. BELOW LSD ft		-	-		
TELD IN GPM					
ATER TEMP. C /2.1 6-2-82		-			
PECIFIC COND. at 25°C 621 (-2-82					
IBMO FILE NUMBER					
NR FILE NUMBER					
VELL FORM NUMBER					
IBMO WQ LAB. NUMBER	-	-	(N	SKETCH MAP	
YS 2000 NUMBER				1/2	THE MILLE
THER:		1			
	Til	1.1			
REMARKS: GUINER WOULDN- QUEW	1:1-1-	لنا	L_ 7		
- S - SWL					
511 22 920106					
115 01/3/100					C-29
F - FLOWING	-				C - 2 9
MBMG Form 182 (9/79)	1.01				
	1.01	. 0			

COUNTY PRESCREE T. 1	2 Nors	R	4 ENW SEC. 27 TRACT ACBD
o , , , , , , , , , , , , , , , , , , ,	11		
LAT N. LONG	w.		UTM N E
TOWN SUBDIVISION _			BLOCK LOT
OWNER'S NAME NICKMAN YOUNG			ADDRESS TAND DULEE, PT
OWNER'S NAME NORMAN YOUNG FOLY R JUNER / MURRY M. SUT	-1. R.E		
			YEAR
ALT. LAND SURF. AT WELL MSL 38 25 11.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD 423 M.	INTERV	AL (FT.)	
	FROM		DESCRIPTION
STATIC WATER LEVEL® BELOW LSO #1.	FROM	то	
YIELD IN GALLONS PER MIN.	0	19	CLAY
HOW TESTED TIME (HR.)	14	22	REL GEL
IF F, SHUT-IN PRESS. IN PSI	22	24	SANDSTONE
	24	29	ELL 681
GEOLOGICAL SOURCE OF H20 [Coolera] Fin and	23	41	SHALEROOM
Turces, a cendal.	4!	47	SHALE-GREY
CASING DIA In. FROM O M. TO 70 M.	47	64	SOFT-RELBEL
	64	99	SHALE ROCK
CASING TYPE - FON	99	101	SANISTONE
PERFORATED INTERVALft. TOft.	101	112	SIALE FOCK
n. TO n.	112	122	SHICE POSKE AND TONE STRING
ft. TOft.	122	145	SINLETONE
PERFORATION DESC.	145	198	SAREKOSH
PUMP SIZE (HP.) TYPE ECOUTE C	148		SHALE ROLE SCINESTONE
DATE WELL COMPLETED 4-25-61	. 63	172	RED BED
HOW DRILLED ROTARY	172		SANLY SLALE ROSE 1 A D
BY WHOM SOC NAICHSEN DRILLING LIC. 5	184	214	
WELL USE DOMESTIC	214	223	
SOURCE OF INFO: WELL APPROP.	223		REL BED
DRILLER OWNER USQS SCS	233	345	
OTHER:	245		COAL
	253	260	
HAS WELL LOCATION BEEN VERIFIED YES	260	274	
BY WHOM W. GENTAN M AGENCY MBMG	274	-	SHALE ROCK CONGLOMERATION
DATE VERIFIED 6-5-82			SANUSTONE
MEAS. POINT ABOVE LSO			
TOTAL DEPTH BELOW LSDft			
PUMPING LEVEL BELOW LSO ft			
SWL® BELOW LSD ft			
WATER TEMP. C			
SPECIFIC COND. at 25 C			
MBMG FILE NUMBER			
ONR FILE NUMBER			
WELL FORM NUMBER			
MBMG WQ LAB. NUMBER			SKETCH MAD STEAM CONLEE
SYS 2000 NUMBER			
OTHER:			Jun 15 A
			~~~~
REMARKS: WELL WAS UNDER WATER			1
IN FLOOREN FACEMENT, No S.C. DR			1º Well
INL MUNICAGIE			
			C-30
F = FLOWING			
MBMG Form 182 (9/79)			

COUNTY CASCADE T. Z		A	4 (E) W	sec. 36	TRACT DBBB
• ! H . LONG.	w.		UTM	_ N	E
TOWN SUBDIVISION				BLOCK	LOT
OWNER'S NAME ROBERT KLASN	eR		ADDRESS	STOCKETT	MT. 594
	PHONE	NUMBER .		YEAR	
ALT. LAND SURF. AT WELL MSL 3625 11			LITHOLO	GIC LOG	
TOTAL DEPTH BELOW LSD 830 m PUMPING LEVEL BELOW LSD A 101 10171 M m STATIC WATER LEVEL® BELOW LSD 300 m	FROM	TO		DESCRIPTION	
YIELD IN GALLONS PER MIN.	0	2	Tols	011	
HOW TESTED AND DOWN TIME (HR.)				NITH GRAU	vel .
		156	SHALE	·	
GEOLOGICAL SOURCE OF H20	6			STONE	
MAD SON				CPROX 10	PM
			700'	10-15 61	017
CASING DIA TIN. FROM 0 1. TO 60 1					
in. FROM ft. TO ft.	1		MPROX	5061M	
CASING TYPE TECL					
PERFORATED INTERVAL ft. TO ft.	į.				
n. TO n					
n. TOn					
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED 12/14/77 HOW ORILLED FORMACD ROTTARY					
BY WHOM A & G. DG. 11. NG LIC. 247					
WELL USE MUNICIPAL					
SOURCE OF INFO: WELL APPROP.					
DRILLER OWNER USOS SCS					
OTHER:					
HAS WELL LOCATION BEEN VERIFIED YES			-		
BY WHOM HERMIN MOUNE AGENCY MBMG		-			
DATE VERIFIED 6/01/82	-	-			
MEAS. POINT ABOVE LSO ft. DATE					
TOTAL DEPTH BELOW LSO ft					
PUMPING LEVEL BELOW LSD ft					
SWL* BELOW LSD ft		-			
YIELD IN OPM		-			
WATER TEMP. °C					
SPECIFIC COND. at 25 C		-			
MBMG FILE NUMBER					
ONR FILE NUMBER					
WELL FORM NUMBER				KETCH MAP	
MBMQ WQ LAB. NUMBER		T.		AND THE REAL PROPERTY.	
SYS 2000 NUMBER		111	1	Te	
OTHER:	30			To CONTER-IIIC	
CH II D- Comment De	:		/		
MEMARKSI Thous De Conpins By	handa da	N			
- ME CNO OL July b			1		
			AT		
*F * FLOWING			, 10	1012 10-26	C-31
MRMG Form 182 (9/79)	57	2	1		

COUNTY CASCADE T. 1		R. 50	rw sec. 7	TRACT BODC
LAT N. LONG	w.	UTM	N	E
TOWN SUBDIVISION _				
OWNER'S NAME GEORGE HEAL WO	e/1 2	ADDRES	s SAND COSIE	3C
	PHONE NU	MBER	YEA	AR
ALT. LAND SURF. AT WELL MSL 3455 11.			HOLOGIC FOG	
TOTAL DEPTH BELOW LSD 2-20 ft.	INTERVA	L (FT.)	DESCRIPTIO	A.
PUMPING LEVEL BELOW LSD ft.  STATIC WATER LEVEL® BELOW LSD ft.	FROM	то	DESCRIPTIO	
YIELD IN GALLONS PER MIN.				
HOW TESTED TIME (HR.)				
GEOLOGICAL SOURCE OF H20 Well INTO LIMESTONE				
Whenever must Have kepinge from				
Treem 10' AWRY (1)				
CASING DIA. 6 In. FROM				
In. FROM ft. TO ft.				
PERFORATED INTERVAL ft. TO ft.				
ft. TOft.				
PUMP SIZE (HP.) TYPE				
DATE WELL COMPLETED				
BY WHOM LIC			7.00	
WELL USE STOCK				
SOURCE OF INFO: WELL APPROP.				
DRILLER OWNER X USQS SCS				
OTHER:				
OTHER:				
HAS WELL LOCATION BEEN VERIFIED YES				
BY WHOM HERMAN MOURE AGENCY MAMG				
DATE VERIFIED 6/64/82				
MEAS. POINT ABOVE LSD _/. 5 ft. DATE				
TOTAL DEPTH BELOW LSD1t.				
PUMPING LEVEL BELOW LSD ft.  SWL+ BELOW LSD 6.33 n. 44/82				
YIELD IN OPM				
WATER TEMP.°C /3.7 4/04/82				
SPECIFIC COND. at 25°C /667 6/04/82				
MBMG FILE NUMBER				
DNR FILE NUMBER				
WELL FORM NUMBER				
MBMG WG LAB. NUMBER			SKETCH MAP	11.
SYS 2000 NUMBER		A (2)	,	1es lowers in
OTHER:	7-			Lo by Hen on land
REMARKS: 1 - 1 1 - C		E N /	T=	Toleford Fole
- W (((C))				- 13
6 ( - 2 + 1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2   1 - 2				
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*F * FLOWING			teac!	x - Sprills
MBMG Form 182 (9/79)			11-1-9	

COUNTY CASCADE T.	Z. Aors	A	I CON W	sec. 7_	TRACT _ BDE
0 1 H 0 1	w.		UTM	N	ε
TOWN SUBDIVISION _				BLOCK	LOT
OWNER'S NAME JIM ERICKSON			ADDRESS .	- AND	Coulee MI.
	PHONE N	UMBER.		YE.	AR
ALT. LAND SURF. AT WELL MSL 2453 11.			LITHO	LOGIC LOG	
TOTAL DEPTH BELOW LSD 2/4 1.  PUMPING LEVEL BELOW LSD 1.	FROM	TO		DESCRIPTION	ON
STATIC WATER LEVEL® BELOW LSO 11.  YIELD IN GALLONS PER MIN. 3.5					
HOW TESTED TIME (HR.)					
OEOLOGICAL SOURCE OF H20 LIME STONE					
Manison Manison					
CASING DIA. 2 In. FROM N. TO N.					
in. FROM ft. TO ft.				<u></u>	
CASING TYPE STEEL 11. TO 11.					
PERFORATED INTERVAL ft. TO ft.					
п. то п.					
ft. TO ft.					
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED					
HOW DRILLED					
BY WHOM LAT BYRNE LIC.					
WELL USE					
SOURCE OF INFO: WELL APPROP.					
DRILLER OWNER X USQS SCS					
OTHER:					
HAS WELL LOCATION BEEN VERIFIED YES					
BY WHOM HERMAN MORE AGENCY MBML					
BY WHOM FICK POND FIDINGE AGENCY LIGHTE					
DATE VERIFIED 6/02/22					
MEAS. POINT ABOVE LSD ft. DATE					-
TOTAL DEPTH BELOW LSD					
PUMPING LEVEL BELOW LSO ft.					
SWL BELOW LSD ft.					
YIELD IN GPM					
WATER TEMP. C					
SPECIFIC COND. at 25 C					
MBMG FILE NUMBER					
DNR FILE NUMBER				···	
WELL FORM NUMBER				ANG TON MAR	
MBMG WQ LAB. NUMBER		4		SKETCH MAP	. ack
SYS 2000 NUMBER				IND Coulee	CREET
OTHER:	7.		Gy /	.,, ,,,	
REMARKS. Dell is PART OF TRACY WATER SISTEM		:		TRACY	
TRACY WATER SUSTEM			MA	- Well	
F. FLOWING		/	11	2 NO CATE	lovie on street
MBMG Form 182 (9/79)		/	1		C-33

COUNTY LASCADE T. L	L Dors	R. 5 (3)	W SEC/	8 TRACT BAC			
0 1 11 0 1 LAT N. LONG	W.	UTM	N _	Ε			
OWN SUBDIVISION .			BL	OCK LOT			
OWNER'S NAME ANDY TESINSKY		ADDRESS	SAND	Coslee MT.			
,				YEAR			
ILT. LAND SURF. AT WELL MSL 3460 M.							
	INTERVAL		LITHOLOGIC LOG				
			DESC	RIPTION			
TATIC WATER LEVEL® BELOW LSD	FROM	ТО					
VIELD IN GALLONS PER MIN.							
HOW TESTED TIME (HR.)							
FF, SHUT-IN PRESS. IN PSI DEOLOGICAL SOURCE OF H ₂ 0 LIME STOWE (2)							
2							
CASING DIA. & In. FROM n. TO n.							
In. FROM ft. TO ft.	1						
CASING TYPE STECK							
ERFORATED INTERVAL ft. TO ft.							
ft. TO ft.							
ft. TO ft.							
ERFORATION DESC.							
PUMP SIZE (HP.) TYPE							
DATE WELL COMPLETED							
HOW DRILLED							
BY WHOM LIC							
WELL USE Domestic							
SOURCE OF INFO: WELL APPROP.							
ORILLER OWNER X USGS SCS							
OTHER:							
HAS WELL LOCATION BEEN VERIFIED YES							
BY WHOM HEIRMAN MOORE AGENCY MBMG							
DATE VERIFIED 6/10/82							
MEAS. POINT ABOVE LSD ft. DATE							
TOTAL DEPTH BELOW LSD ft							
PUMPING LEVEL BELOW LSO ft.							
WL BELOW LSD 148.68 m. 6/10/82							
TELD IN GPM							
VATER TEMP. C 15.2 6/10/82							
PECIFIC COND. at 25 C 6/7 6/10/82							
ABMG FILE NUMBER							
ONR FILE NUMBER							
VELL FORM NUMBER							
ABMO WO LAB. NUMBER	COLUMN TO STATE OF THE STATE OF	1	BRETCH MA	Hear			
YS 2000 NUMBER		1 asal	EMETCH MI				
OTHER:	18	/-		16030			
		1 8/-		Do-well			
REMARKS:	Lilili	1 1					
		KKM /	` `.	. /			
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F - FLOWING		_\ Y \	1	reser			
MBMG Form 182 (9/79)	72	7 X	1 }	C-34			
MOISO LAURING FALLAL	LAND NE	I ALL TO ALL	7				

TOWN SUBDIVISION BLOCK LOT (NIMORET)  OWNER'S NAME ARRY MC FWCN ADDRESS AND CLUBER MT.  PHONE NUMBER YEAR  ALT. LAND SURF. AT WELL MSL 3457 n.  FOUMPING LEVEL BELOW LSD /42 n.  FOUMPING LEVEL BELOW LSD /55 n.  FROM TO DESCRIPTION  STATIC WATER LEVEL'S BELOW LSD /43 n.  VIELD IN GALLONS PER MIN.  HOW TESTED BAI/CR TIME (HR.) 1 20 30 TOP OIL  IFF. SHUTHN PRESS. IN PSI  GEOLOGICAL SOURCE OF M20 LINIC STAVE MALIC  LIN. FROM n. TO n.  CASING DIA 2 In. FROM n. TO 162 n.  In. FROM n. TO n.  RY 10 CARPY ARCKEN SHALE  CASING TYPE PERFORATION DESC.  PERFORATION DESC.  PUMP SIZE (HP.) TYPE  DATE WELL COMPLETED 3/7/2 HARC  SOURCE OF INFO! WELL APPROP. X.  ORILLER OWNER USGS SCS  OTHER!  HAS WELL LOCATION BEEN VERIFIED YCS.  BY WHOM MALARMAN MAGGER AGENCY MARIGE  PERSON TORILLED CATION BEEN VERIFIED YCS.  BY WHOM MALARMAN MAGGER AGENCY MARIGE  SUR WORLD LOCATION BEEN VERIFIED YCS.  BY WHOM MALARMAN MAGGER AGENCY MARIGE  BY WHOM MACRE AGENCY MARIGE  BY WHOM MALARMAN MAGGER AGENCY MARIAR  BLOTT MACRA MAGGER MACHEN  BLOCK LOT MACRA MAGGER MACHEN  BLOCK LOT MACHAM MACHEN  LITHOLOGIC DOT MACHAM MACHEN  LITHOLOG
OWNER'S NAME LARRY MCEWEN ADDRESS AND CLUBE MT.  PHONE NUMBER YEAR  ALT. LAND SURF. AT WELL MSL 3457 II.  TOTAL DEPTH BELOW LSD /55 II.  PUMPING LEVEL BELOW LSD /55 II.  STATIC WATER LEVEL' BELOW LSD /43 II.  VIELD IN GALLONS PER MIN.  HOW TESTED BAILER TIME (HR). D 20 30 YELLOW SHALE  IF F, SHUTTIN PRESS. IN PSI  GEOLOGICAL SOURCE OF H20 LICE STOWE  CASING DIA Q II. FROM Q II. TO II.  CASING TYPE PERFORATED INTERVAL III. TO II.  III. FROM III. TO II.  PERFORATED INTERVAL III. TO II.  PERFORATION DESC.  PUMP SIZE (HR) TYPE  DATE WELL COMPLETED 3/7/18 III.  BY WHOM PAT BYRNE LIC. 135  WELL USE DOMESTIC  BY WHOM PAGE AGENCY MARKS  BY BACTOURIST  LITHOLOGICA AGENCY MARKS  LITHOLOGICA AGENCY MARKS  LITHOLOGICA AGENCY MARKS  LITHOLOGICA AGENCY MARKS  LITHOLOGICA AGENCY MA
OWNER'S NAME LARRY MC FOCK  ADDRESS SUM CLUBER MT.  ALT. LAND SURF. AT WELL MSL  TOTAL DEPTH BELOW LSD  JEST R.  TOTAL DEPTH BELOW LSD  JOST R.  FROM TO  DESCRIPTION  TO DESCRIPTION  JOST ROW SHALE  JOST R.  SAND STONE  DESCRIPTION  DESCRIPTI
ALT. LAND SURF. AT WELL MSL 3457 TI.  TOTAL DEPTH BELOW LSD /22 TI.  FUMPING LEVEL BELOW LSD /55 TI.  STATIC WATER LEVEL' BELOW LSD /43 TI.  HOW TESTED BAILOR TIME (HR.) 1  JO 34 DENTIONITE  GEOLOGICAL SOURCE OF H20 LINE STANCE  CASING DIA & In. FROM 0 TI. TO 62 TI.  FROM TO DESCRIPTION  TO 10 34 DENTIONITE  GEOLOGICAL SOURCE OF H20 LINE STANCE  LINE FROM 1 TO 1 TIME (HR.) 1  AND TO 1 TIME (HR.) 2  JO 34 DENTIONITE  38 YEAR YELLOW SHALE  49 ST HARD SAND ROCK  45 R5 GRAY SHALE  49 ST HARD SAND ROCK  45 R5 GRAY SHALE  40 STANCE SHALE  10 FROM TI. TO TI.  10 SAND STANCE SHALE  10 III SAND STANCE WATER LEVEL SHALE  10 III SAND STANCE WATER LEVEL  10 III CARSTONE WATER LEVEL  10 III CARSTONE  11 III CARSTONE  12 III O MARC SAND ROCK  13 III CARSTONE  14 III O MARC SAND ROCK  15 III CARSTONE  17 III CARSTONE  17 III CARSTONE  18 YOUR STANCE  19 III CARSTONE  19 III CARSTON
ALT. LAND SURF. AT WELL MSL 3457 N.  FOUNDEING LEVEL BELOW LSD /55 N.  STATIC WATER LEVEL'SELOW LSD /43 N.  VIELD IN GALLONS PER MIN.  HOW TESTED BAILER TIME (HR.) 1 2 20 30 Yellow SHALE  GEOLOGICAL SOURCE OF H20 LINE STONE  TO ALLONS STAND SHALE  CASING DIA & In. FROM A N. TO 62 N.  CASING DIA & In. FROM N. TO N.  CASING TYPE  PERFORATION DESC.  PUMP SIZE (HP.)  TYPE  DATE WELL COMPLETED 3 71 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
ALT. LAND SURF. AT WELL MSL 3457 N.  FOUNDEING LEVEL BELOW LSD /55 N.  STATIC WATER LEVEL'SELOW LSD /43 N.  VIELD IN GALLONS PER MIN.  HOW TESTED BAILER TIME (HR.) 1 2 20 30 Yellow SHALE  GEOLOGICAL SOURCE OF H20 LINE STONE  TO ALLONS STAND SHALE  CASING DIA & In. FROM A N. TO 62 N.  CASING DIA & In. FROM N. TO N.  CASING TYPE  PERFORATION DESC.  PUMP SIZE (HP.)  TYPE  DATE WELL COMPLETED 3 71 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
PUMPING LEVEL BELOW LSD  PUMPING LEVEL BELOW LSD  JSS N.  FROM TO  DESCRIPTION  DES
PUMPING LEVEL BELOW LSD /55 n.  STATIC WATER LEVEL* BELOW LSD /43 n.  VIELD IN GALLONS PER MIN. 40  HOW TESTED BAILER TIME (HR.) 1 2 20 30 Yellow SHALE  FF. SHUTHN PRESS. IN PSI  GEOLOGICAL SOURCE OF H20 LICE STONE  MADJON 2 10 10 38 MENTONITE  GEOLOGICAL SOURCE OF H20 LICE STONE  IN FROM 0 n. TO /62 n.  EASING DIA & In. FROM 0 n. TO /62 n.  IN FROM n. TO n.  CASING TYPE  PERFORATED INTERVAL 11. TO n.  PERFORATION DESC.  PUMP SIZE (HP.) TYPE  DATE WELL COMPLETED 3/7/63  BY WHOM PAT BY RIVE LICE 135  WELL USE DOMESTIC  BY WHOM LORD WELL APPROP. X  ORILLER OWNER USGS SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED Yes  BY WHOM LORD AGENCY MANG
STATIC WATER LEVEL BELOW LSD 143 PL.  VIELD IN GALLONS PER MIN.  HOW TESTED BAILER TIME (HR.) 2  IF F, SHUTHN PRESS. IN PSI  GEOLOGICAL SOURCE OF H20 LICESTAND  CASING DIA & In. FROM 0 PL. TO 62 PL.  In. FROM PROME PERFORMENT PROPERTY OF THE PROPERTY OF
STATIC WATER LEVEL BELOW LSD /43 PL  VIELD IN GALLONS PER MIN. 40  HOW TESTED BAILER TIME (HR.) 2  JEF, SHUTHIN PRESS. IN PSI  GEOLOGICAL SOURCE OF H ₂ O LIME STAVE  MADISON  CASING DIA & In. FROM Q PL. TO /62 PL  In. FROM N. TO PL  CASING TYPE  PERFORATED INTERVAL PL. TO PL  PERFORATION DESC.  PUMP SIZE (HP.) TYPE  DATE WELL COMPLETED 3/7/3 A  ORILLER DWNER USGS SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED YES  BY WHOM //CREAN MODER AGENCY MANGE  BY WHOM //
HOW TESTED BAILER TIME (HR.) 1  IF F, SHUT-IN PRESS. IN PSI  GEOLOGICAL SOURCE OF H20 LIME STONE  MADISON  CASING DIA & In. FROM O n. TO 162 n.  In. FROM n. TO n.  CASING TYPE  PERFORATED INTERVAL n. TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.  TO n.
GEOLOGICAL SOURCE OF H20 LINE STONE  GEOLOGICAL SOURCE OF H20 LINE STONE  MADION 40 ST HARD SAND ROCK  (S & S GRAY SHALE  LINE FROM 0 11. TO 12. 12. SAND STONE  CASING DIA & In. FROM 11. TO 12. II. SAND STONE  PERFORATION DESC.  PUMP SIZE (HR.)  BY WHOM PAT BY RUE LIC. 135  WELL LOCATION BEEN VERIFIED YOS  BY WHOM ALCREAN MORE AGENCY MAKE  1. TO 12. SAND STONE  1. TO 12. SAND STONE LOST WATER  1. TO 12. SAND STONE LOST WATER  1. TO 12. SAND STONE  1. TO 13. SAND STONE  1. TO 14. SAND STONE  1. TO 15. SAND STONE  1. TO 16. SAND STONE  1. TO 17.
GEOLOGICAL SOURCE OF H20 LINE STONE  MADISON  CASING DIA. & In. FROM O. R. TO 162 R.  In. FROM N. TO R.  CASING TYPE  PERFORATION DESC.  PUMP SIZE (HP)  DATE WELL COMPLETED 3/7/63  HOW ORILLED CHURN DRILL  BY WHOM PAT BYRNE LIC. 135  HOW ORILLER DWNER USGS SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED YCS  BY WHOM 1/CRMAN MODEL AGENCY MANG
CASING DIA & In. FROM Q N. TO 162 N.  In. FROM N. TO N.  In. FROM N. TO N.  CASING TYPE  PERFORATED INTERVAL  N. TO N.  N. TO
CASING DIA & In. FROM D R. TO 162 R. BS 69 SAND STONE  In. FROM R. TO R. BY 105 GRAY BROKEN SHALE TENDS  CASING TYPE  PERFORATED INTERVAL R. TO R. 1/0 ILS SAND STONE WITER LOST WATER  R. TO R. 1/5 I22 SAND STONE WITER LOST WATER  PERFORATION DESC.  PUMP SIZE (HP.) TYPE  DATE WELL COMPLETED 3/7/62  HOW ORILLED CHURN DRILL  BY WHOM PAT BYRNE LIC. 135  WELL USE DOMESTIC  SOURCE OF INFO! WELL APPROP. X  ORILLER DWNER USGS SCS  OTHER!  HAS WELL LOCATION BEEN VERIFIED YES  BY WHOM MERCATON MODER AGENCY MANGE
CASING DIA & In. FROM O N. TO 162 N. 85 & 9 SAND STONE  IN. FROM N. TO N. 89 105 GRAY BROKEN SHALE TENDER  CASING TYPE  PERFORATED INTERVAL N. TO N. 110 115 SAND STONE WOTER SPM  N. TO N. 115 123 SAND STONE WOTER SPM  PERFORATION DESC.  PUMP SIZE (HP.) TYPE  DATE WELL COMPLETED 3/7/68  HOW ORILLED CHURN DRILL  BY WHOM PAT BY RUE LIC. 135 147 153 SAND STONE  WELL USE DOMESTIC  SOURCE OF INFO! WELL APPROP. A  ORILLER DWNER USGS SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED YES  BY WHOM MARCH AGENCY MBMG
In FROM N. TO TO TO TO SAME BROKEN SHALL FLOW TO THE PERFORMATED INTERVAL TO
In FROM N. TO TO TO TO SAME BROKEN SHALL FLOW TO THE PERFORMATED INTERVAL TO
CASING TYPE  PERFORATED INTERVAL  R. TO  R.
PERFORATED INTERVAL  11. TO  12. TO  13. TO  14. TO  15. TO  16. TO  17. TO  17. TO  17. TO  18. TO  19. TO  1
m. to m. 1/5 122 SANDSTONE LOST WATER  m. to m. 1/2 130 MARK SANDROCK  PERFORATION DESC.  PUMP SIZE (HP.) TYPE  DATE WELL COMPLETED 3/7/68  HOW ORILLED CHURN DRILL  BY WHOM PAT BYRNE LIC. 135  WELL USE DOMESTIC  SOURCE OF INFO! WELL APPROP. X  ORILLER OWNER USGS SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED YES  BY WHOM //CRMAN MODER AGENCY MBMG
PERFORATION DESC.  PUMP SIZE (HP.) TYPE  DATE WELL COMPLETED 3/7/1/8  HOW ORILLED CHURN DRILL  BY WHOM PAT BYRNE LIC. 135  WELL USE DOMESTIC  SOURCE OF INFO! WELL APPROP. A  ORILLER OWNER USGS SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED YES  BY WHOM //CRMAN MODEL AGENCY MANG
PERFORATION DESC.  PUMP SIZE (HP.) TYPE  DATE WELL COMPLETED 3/7/18  HOW ORILLED CHURN DRILL  BY WHOM PAT BYRNE LIC. 135  WELL USE DOMESTIC  SOURCE OF INFO! WELL APPROP. X  ORILLER OWNER USGS SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED YES  BY WHOM //CRMAN MODEL AGENCY MANG
PUMP SIZE (HP.) TYPE  DATE WELL COMPLETED 3/7/18  HOW ORILLED CHURN DRILL  BY WHOM PAT BY RNE LIC. 135  WELL USE DOMESTIC  SOURCE OF INFO! WELL APPROP. X  ORILLER DWNER USGS SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED YES  BY WHOM //CRMAN MODEL AGENCY MANG
DATE WELL COMPLETED 3/7/68 HOW ORILLED CHURN DRILL BY WHOM PAT BY RNE LIC. 135 WELL USE DOMESTIC SOURCE OF INFO! WELL APPROP. X ORILLER DWNER USGS SCS OTHER:  HAS WELL LOCATION BEEN VERIFIED YES BY WHOM //CRMAN MODEL AGENCY MBMG
HOW ORILLED CHURN DRING  BY WHOM PAT BYRNE LIC. 135  WELL USE DOMESTIC  SOURCE OF INFO! WELL APPROP. A  ORILLER OWNER USQS SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED YES  BY WHOM //CRMAN MODER AGENCY MBMG
BY WHOM PAT BYRNE LIC. 135  WELL USE DOMESTIC  SOURCE OF INFO! WELL APPROP. A  ORILLER DWNER USQS SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED YES  BY WHOM //CRMAN MODER AGENCY MBMG
WELL USE DOMESTIC  SOURCE OF INFO! WELL APPROP. X  ORILLER OWNER USGS SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED Yes  BY WHOM //CRMAN MODER AGENCY MBMG
ORILLER DWNER USGS SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED YES  BY WHOM [CRMAN MODEL AGENCY MBMG]
ORILLER OWNER USGS_ SCS  OTHER:  HAS WELL LOCATION BEEN VERIFIED Yes  BY WHOM //CRMAN MODEL AGENCY MBMG
HAS WELL LOCATION BEEN VERIFIED YOS  BY WHOM FICE MAN MODEL AGENCY MBMG
HAS WELL LOCATION BEEN VERIFIED Yes  BY WHOM FIGHT AN MODEL AGENCY MBMG
HAS WELL LOCATION BEEN VERIFIED Yes  BY WHOM HERMAN MODEL AGENCY MBMG
BY WHOM HERMAN Model AGENCY MBMG
DATE VERIFIED 6/10/82
MEAS, POINT ABOVE LSD ft. DATE
PUMPING LEVEL BELOW LSO ft.
SWL. BELOW LSD n.
WATER TEMP. C 4/0/82
0 (2/1 // // // )
SPECIFIC COND. at 25°C 634 6/10/82
MBMG FILE NUMBER
DNR FILE NUMBER
WELL FORM NUMBER
MBMG WG LAB. NUMBER
SYS 2000 NUMBER
OTHER:
REMARKS: BOTALLE TOSTE SINCE TITLE - N MICH - ev
Comile's Entimenter's old well
CAUCO IN.
and the inco
·F - FLOWING
MBMG Form 182 (9/79)

COUNTY CASCAde T. 1		R.	5 EOW SEC. 18 TRACT CROD
0 1 H 0 1	w.		UTM N E
TOWN SUBDIVISION _			
OWNER'S NAME TERRY NET			ADDRESS BOX 95 STAR RT. STOCK
	PHONE N	NUMBER	YEAR
ALT. LAND SURF. AT WELL MSL 3455 H.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD 175' #.	INTERV	AL (FT.)	
PUMPING LEVEL BELOW LSD /72 n.	FROM	то	DESCRIPTION
STATIC WATER LEVEL BELOW LSD		2	Tacii
VIELD IN GALLONS PER MIN. 40	0		BROKEN SANDSTONE
HOW TESTED TIME (HR.) 1	2	35	
IF F, SHUT-IN PRESS. IN PSI	36	40	SAND STONE
GEOLOGICAL SOURCE OF H20 MADISON	40	49	Yellow Clay
	49	54	Broken SANDSTONE
CASING DIA. 2 In. FROM O tt. TO 100 tt.		64	Broken SANDSTONE
(2) In. FROM 100 ft. TO 175 ft.		67	Broken GREY SAND STONE
CASING TYPE STEEL	6.7	70	
PERFORATED INTERVALft. TOft.	70	85	GREB SHALE
ft. TO ft.	85	105	
ft. TO ft.	105	175	11Mestoke
PERFORATION DESC.			
PUMP SIZE (HP.) TYPE			
DATE WELL COMPLETED		-	
HOW ORILLED			
WELL USE DOMESTIC & STOCK		ļ	
SOURCE OF INFO: WELL APPROP.		-	
ORILLER OWNER USGS SCS			
OTHER:			
		-	
HAS WELL LOCATION BEEN VERIFIED			
DATE VERIFIED 605/82			
MEAS. POINT ABOVE LSD ft. DATE			
TOTAL DEPTH BELOW LSD ft			
PUMPING LEVEL BELOW LSO 172 M. 405/ PZ			
SWL* BELOW LSD 79.76 m. 6/19/82			
YIELD IN GPM //.25 6/19/82			
WATER TEMP. C 2.5 6/05/82			
SPECIFIC COND. at 25°C 597 1/19/82			
MBMG FILE NUMBER		ļ	
DNR FILE NUMBER			
WELL FORM NUMBER		L	
MBMG WQ LAB. NUMBER		m (	TO TOTALY SKETCH MAP
SYS 2000 NUMBER		11 PG	11 - 1000
OTHER:	1/8-		MUMBER SPURN
DEMARKS		N	RURLINGTON NORTHERN
REMARKS:		2/	
		-	
			17.11
*F = FLOWING			C-36
M8MG Form 182 (9/79)			well
			ITO CENTERVILLE

COUNTY CASCADE T.	-		
AT N. LONG	w.		UTM N E
OWN SUBDIVISION			BLOCKLOT
WHER'S HAME KULY MARKO			ADDRESS SCALD CONSC
	PHONE	NUMBER	YEAR
LT. LAND SURF. AT WELL MIL 3455 M. OTAL DEPTH BELOW LSD			LITHOLOGIC LOG
			DESCRIPTION
ATIC WATER LEVEL BELOW LSO 45 n.	FROM		
	-	135	/
ELO IN GALLONS PER MIN.  DW TESTED TIME (HR.)	185	190	LinesTone
F CAME AN DOFFE IN DEL			
COLOGICAL SOURCE OF H20 IMP STONE			
MUDITON			
	7. )	MAD	327
SING DIA & In. FROM Q R. TO 60 R.			
SING TYPE STEEL			
FORATEO INTERVAL ft. TO ft.		1	
ħ. TO ħ.			
ft. TO ft.			
REFORATION DESC.		-	
MP SIZE (HP.) TYPE	-	-	
TE WELL COMPLETED 1940		-	
W DRILLED			
WHOM MAPHIT LIC.			
LLUSE POMESTIC & STOCK			
URCE OF INFO: WELL APPROP.			
ILLER OWNER X USGS SCS			
HERI			
S WELL LOCATION BEEN VERIFIED YES			
WHOM HERMAN MOORE AGENCY MBMG			
TE VERIFIED 6/09/82			
AS. POINT ABOVE LSO ft. DATE			
AL DEPTH BELOW LSD ft			
PING LEVEL BELOW LSO ft			
BELOW LSO ft			
LOIN GPM			
TER TEMP.°C 17.9 6/09/82 CIFIC COND. at 25°C 587 4/09/82			
CIFIC COND. at 25 C 587 409/82			
MO FILE NUMBER			
R FILE NUMBER			
LL FORM NUMBER			
MG WQ LAB. NUMBER		,	SKETCH MAP
S 2000 NUMBER		- A	TRACY
HERI	/8-		( Thunger even
MARKS:		1 · · · · · ·	
		(227)	7
		(4)	
			A MACN
- FLOWING			C-37
BMG Form 182 (9/79)			O-LIF II

COUNTY CASCADE T. 1		R	5 Corw	sec. 18	TRACT DCDC
o 1 H O 1	**		PEA	M	ε
LAT N. LONG.	w.	,	OTM		
TOWN SUBDIVISION _				BLOCK	LOT
OWNER'S NAME CENTOR UILLE SENIOR C	Tizen	S B16. A	ADDRESS _	SAND LOU	lee
	PHONE N	UMBER_		YEAF	
ALT. LAND SURF. AT WELL MSL 3475 ft.			LITHOL	OGIC LOG	
TOTAL DEPTH BELOW LSD 200 M.	INTERV	AL (ET)	LITHOL	DGIC LOG	
PUMPING LEVEL BELOW LSD				DESCRIPTION	
STATIC WATER LEVEL® BELOW LSD	FROM	то			
YIELD IN GALLONS PER MIN.					
HOW TESTED TIME (HR.)					
IF F, SHUT-IN PRESS. IN PSI					
GEOLOGICAL SOURCE OF H20 LINE STONE					
MADISON					
CASING DIA. E In. FROM ft. TO ft.					
In, FROM ft. TO ft.					
CASING TYPE PIRSTIC					
PERFORATED INTERVAL ft. TO ft.					
ft. TO ft.					
ft. TOft.					
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED					
HOW DRILLED					
BY WHOM LIC					
WELL USE DOMCSTIC					
SOURCE OF INFO: WELL APPROP.					
ORILLER OWNER USGS SCS					·····
OTHER: Heal - PRESENT WHEN DRIVED					
~					
HAS WELL LOCATION BEEN VERIFIED Yes					
BY WHOM HERMAN MOORE AGENCY MBIME					
DATE VERIFIED 6/09/52		-			
MEAS. POINT ABOVE LSO ft. DATE					
TOTAL DEPTH BELOW LSD ft				*	
PUMPING LEVEL BELOW LSD ft.					
SWL BELOW LSD 122.92 M. 4/99/22					
YIELD IN GPM		-			
WATER TEMP. C /3./ 6/0882				<del></del>	
SPECIFIC COND. at 25 C 2292 409/82					
MBMG FILE NUMBER					
ONR FILE NUMBER					
WELL FORM NUMBER				SKETCH MAP	
MBMG WQ LAB. NUMBER		III		TO TRACT	
SYS 2000 NUMBER		· (e)	MERVILLE N	10,121101	
OTHER:	10	· Sem	is a Cit.	1-(227)	
REMARKS: 10 NOT USE , NTER	11 11 71	Po	"OING	(	
1 DELAKING FORMY WATER		_	well _	0	
IN THE LEFT WHITE IN USE					
2N MANGE (Ca)				M	
*F * FLOWING				NLENI	eruile -38
MBMG Form 182 (9/79)					C-38

COUNTYASCADE T. 19		R	5 (BOW SEC. 19 TRACT AADC
LAT N. LONG	w.		UTM N E
TOWNSUBOIVISION			BLOCK LOT
OWNER'S NAME THOMAS BEHRENT			ADDRESS STARRI SOND COULED MI
	PHONE P	NUMBER	YEAR
ALT. LAND SURF. AT WELL MSL 3480 H.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD 107 H.	INTERV	AL (FT.)	
PUMPING LEVEL BELOW LSD 95 M.	FROM	то	DESCRIPTION
STATIC WATER LEVEL BELOW LSO 3/ 11	0	10	Tel 5011
VIELD IN GALLONS PER MIN.			
HOW TESTED BALLER TIME (HR.) 2	10	30	Broken SANDSTONES CLAY
IF F, SHUT-IN PRESS. IN PSI	30	35	BROKEN SANDSTONE, GRAVE
GEOLOGICAL SOURCE OF H20 LIME STONE	35	80	VATER COLON SUIT
- MADISW			GRAY SANDY SIIT
C* 125	80	100	BROWN SANDY SITT
CASING DIA 52 In. FROM 0 n. TO 100 h.	100	107	GRAY BROKEN LIMESTONE
In. FROM ft. TO ft.			
CASING TYPE STEEL			
PERFORATED INTERVAL 3/ H. TO 35 H.	- 2	-	
n. TO n.	50,	17:1	77
n. TO 1L		-	
PERFORATION DESC. TORCH			
PUMP SIZE (HP.) TYPE			
DATE WELL COMPLETED 3/17/78		-	
HOW DRILLED CABLE		ļ	
BY WHOM POT RYRNE LIC. 135			
WELLUSE DOMESTIC			
SOURCE OF INFOI WELL APPROP. X			
ORILLER OWNER USGS SCS			
OTHER:			
HAS WELL LOCATION BEEN VERIFIED YES			
BY WHOM HERMAN MOURE AGENCY MBMG			
DATE VERIFIED 5/26/82			
MEAS. POINT ABOVE LSD ft. DATE			
TOTAL DEPTH BELOW LSD ft			
PUMPING LEVEL BELOW LSD ft.			
SWL' BELOW LSD 11.			
YIELD IN OPM			
WATER TEMP. C			
SPECIFIC COND. at 25 C			
MBMQ FILE NUMBER			
DNR FILE NUMBER			
WELL FORM NUMBER			SHETCH MAP
MBMQ WQ LAB. NUMBER		100	
SYS 2000 NUMBER	· · · · · ·	1	
OTHER:	17	1	well their
OPALA DAE.			House Cale rea
REMARKS1		N	Je Je lee Per
			1
•F • FLOWING		Lente	C-39
MBMG Form 182 (9/79)			Laton . w )
			1105

COUNTY CASCADE T. 19		R	5 BOW	SEC. 19	TRACT ABAB
0 1 H 0 1	w.	U	тм	_ N	Ē
TOWN SUBDIVISION _				BLOCK	LOT
OWNER'S NAME GRORGE HEAL WAS	11	Ai	DORESS		
	PHONE N	DMBCH		7500	
ALT. LAND SURF. AT WELL MSL 3575 H.			LITHOLO	aic Loa	
TOTAL DEPTH BELOW LSD 4/0 4.	INTERV	AL (FT.)			
PUMPING LEVEL BELOW LSD #1.  STATIC WATER LEVEL® BELOW LSD #1.	FROM	TO		DESCRIPTION	
STATIC WATER LEVEL BELOW LSD ft.					
YIELD IN GALLONS PER MIN.					
HOW TESTED TIME (HR.)	-				
IF F, SHUT-IN PRESS. IN PSI					
GEOLOGICAL SOURCE OF HO LINESTONE					
MANISON					
CASING DIA. 6 In. FROM R. TO R.					
in. FROM ft. TO ft.	-				
CASING TYPE					
PERFORATED INTERVAL ft. TO ft.	-				
ft. TO ft.					
ft. TO ft.					
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE SUB.		-			-
DATE WELL COMPLETED					
HOW DRILLED					
BY WHOM LIC					
WELL USE DOMESTIC 4 Houses					
SOURCE OF INFO: WELL APPROP.					
DRILLER OWNER _X USGS SCS					
OTHER:				<del></del>	
Yar	-				
HAS WELL LOCATION BEEN VERIFIED YES					
BY WHOM HERMAN MOORE AGENCY MBMG					
DATE VERIFIED 402/82				· · · · · · · · · · · · · · · · · · ·	
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSD ft					
PUMPING LEVEL BELOW LSD ft.					
SWL* BELOW LSD M					
VIELD IN GPM				<del></del>	
WATER TEMP. C 9.8 (a/02/8)					
SPECIFIC COND. at 25°C /294 6/02/82					
MBMG FILE NUMBER					
DNR FILE NUMBER					
WELL FORM NUMBER			11.1	KETCH MAP	
MBMG WQ LAB. NUMBER	0.0000.4		1. Tracy	KETCH MAP	
SYS 2000 NUMBER		11.	1-(22-	7)	
OTHER:	19		1		
REMARKS WOLL SPRICE FOUR HOUSES			11		42
AND WATER I STORED A		116	1111	property L.	,,,
45-22-5, 20 GAL HOLDING MAK-BELOWS	· CEN	Tenville	30	- Heals W	011
well will fund PRY water well was	e LENI		- To -	MEATS W	
*F-FLOWING DRIVEO AT LENTERLI'VE	Sen!	10176			C-40
MBMG Form 182 (9/79) Genior Citizens Cuiding	1301		1	renvile	
JCM CHI ZOU DA IONO			ckri	(EIW4)	

COUNTY CASCADE T. 15	( Gors	R	5 POW SEC. 19 TRACT CAAD
O 1 N LONG.			UTM N E
TOWN SUBDIVISION _			BLOCK LOT
OWNER'S NAME RONALD GUISTI			ADDRESS BOX 93 SAND COURCE
	PHONE N	IUM BER	YEAR
ALT. LAND SURF. AT WELL MIL 3487 M.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD 238 n.	INTERV	AL (FT.)	
PUMPING LEVEL BELOW LSO 1.	FROM	то	DESCRIPTION
STATIC WATER LEVEL BELOW LSD ft.	0	10	FIII
YIELD IN GALLONS PER MIN.	10	-	SANDY LOOM
HOW TESTED PUMP TIME (HR.) 2	16	23	
IF F, SHUT-IN PRESS. IN PSI		45	Yellow SAND STONE
GEOLOGICAL SOURCE OF H20 LIME YONE		7	
	50		Yellow line STOR
CASING DIA . In. FROM 2 n. TO 52 n.	50		BROWN LIMESTONE
In. FROM ft. TO ft.	175	238	LIGHT BROWN LIMESTONE
CASING TYPE STEEL			
PERFORATED INTERVAL ft. TO ft.			WATER AT 125-238
ft. TO ft.			
n. TO n.			
PERFORATION DESC.			
PUMP SIZE (HP.) TYPE			
DATE WELL COMPLETED /// 26/79	-		
BY WHOM PAT BYRNE LIC. 318			
WELL USE DOMESTIC			
SOURCE OF INFO! WELL APPROP.			
DRILLER OWNER USGS SCS			
OTHER:			
V -			
HAS WELL LOCATION BEEN VERIFIED YES			
BY WHOM HERMAN MODREAGENCY MBMG	-		
DATE VERIFIED 6/20/82			
MEAS. POINT ABOVE LSO ft. DATE			
TOTAL DEPTH BELOW LSO ft			
PUMPING LEVEL BELOW LSO R. 6/20/82			
YIELD IN GPM			
WATER TEMP. C 13.50 (/20/82			
SPECIFIC COND. at 25°C 9/4 6/30/82			
MBMG FILE NUMBER			
ONR FILE NUMBER			
WELL FORM NUMBER			
MBMG WQ LAB. NUMBER		T. A	SKETCH MAP
SYS 2000 NUMBER			CI DURTERUILE
OTHER:	19	N	
REMARKS: BlowING Well			
		le	
-		Trailer	1 /(27)
·F · FLOWING		bi	C-41
MBMG Form 182 (9/79)		1	9
		VI	To stockett

COUNTY CASCADE T. 1	2 Mars	R.	5 CON SEC. 19 TRACT CAAL
0   H 0	11		UTM N E
N. LONG.	w.		VIM 1
TOWN SUBDIVISION _			BLOCK LOT
OWNER'S NAME BRIAN GUISTI			ADDRESS STAR RT. STOCKETT
	PHONE N	UI MARKED	YEAR
	PHONE	TOMBER	7500
ALT. LAND SURF. AT WELL MISL 35/0 M.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD 290 M.	INTERV	AL (FT.)	
PUMPING LEVEL BELOW LSD 285 m.  STATIC WATER LEVEL* BELOW LSD 205 m.	FROM	то	DESCRIPTION
STATIC WATER LEVEL BELOW LSD ft.		11	BOLLEN ONE
VIELD IN GALLONS PER MIN.	11	7	BROKEN ROUK
HOW TESTED BALLER TIME (HR.) 2	4	27	GRAY SHAJE
HE F. SHUT-IN PRESS. IN PSI	27 55	63	HARD SHALE ROCK HOAT 55'
GEOLOGICAL SOURCE OF H20 LIMESTONE	63	7)	BLACK SAND STONE Wy BURITE
mildion	72	75	RUSTY BROWN SANDSTONE
CASING DIA. ESIN. FROM O M. TO 7/ M.		25	BROWN SAND STONE
		180	
In. FROM ft. TO ft. CASING TYPE STEC!	180		BROWN LIMESTONE 420 AT 283
PERFORATED INTERVAL			
n. Ton.			
PERFORATION DESC.			
PUMP SIZE (HP.) /2 TYPE			
DATE WELL COMPLETED 2/26/78		ļ	
HOW DRILLED CARIE		<u> </u>	
BY WHOM PAT BYRNE LIC. 135		-	
WELL USE DOMESTIC		-	
SOURCE OF INFO: WELL APPROP. X	-	-	
DRILLER OWNER _X USGS SCS		-	
OTHER:	-	-	
Y.,			
HAS WELL LOCATION BEEN VERIFIED YES BY WHOM HERMAN MORRAGENCY MBMG			
DATE VERIFIED 6/03/82		<b>†</b>	
MEAS. POINT ABOVE LSD -450 ft. DATE			
TOTAL DEPTH BELOW LSDft.			
PUMPING LEVEL BELOW LSD ft.			
SWL* BELOW LSD /96.9 m. 6/20/82			
YIELD IN OPM /3.8 6/20/82			
WATER TEMP.°C /20 (103/82			
SPECIFIC COND. at 25°C 826 6/20/82			
MBMG FILE NUMBER		-	
ONR FILE NUMBER		-	
WELL FORM NUMBER		ļ	
MBMG WQ LAB. NUMBER			SHETCH MAP
SYS 2000 NUMBER			( Centerville
OTHER:	12-		
REMARKS:		団へ	
The control of the co			Ji wil (227)
			Contra Do
*F * FLOWING		Carle	5 C-42
MBMG Form 182 (9/79)			Ve To (Tockett

# MONTANA BUREAU OF MINES AND GEOLOGY WELL-DATA SHEET

T N. LONG	11				
T N. LONG	w.		UTM	N	£
WN SUBDIVISION				BLOCK _	LOT
MER'S NAME DIANE KNOX			ADDRESS	Bex 73 St	and Couleer
	PHONE	NUMBER		YEA	AR
T. LAND SURF. AT WELL MIL 3490 M.			LITHO	LOGIC LOG	
TAL DEPTH BELOW LSD 258 M.	INTER	VAL (FT.)			
MPING LEVEL BELOW LSO 258 M.	FROM	ТО		DESCRIPTIO	N
TIC WATER LEVEL BELOW LSD 150 tl.					
DIN GALLONS PER MIN.	0			Soil	
TESTED BOWEN TIME (HR.) 2	10	40	SHA	10	
HUT-IN PRESS. IN PSI	40	258	line	Rock	
GICAL SOURCE OF HO LIMESTONE					
MAdison					
A. 1/4 In. FROM 0 11. TO 20 11.					
6/4 In. FROM 20 N. TO 80 N.					
ED INTERVAL ft. TO ft.					
ft. TO ft.					
ft. TO ft.		-			
TION DESC.		ļ			
(HP.) TYPE					
L COMPLETED 11/14/79		ļ			
ED FLWARD ROTARY					
Supe WATER PRIVERS LIC. 178					
Domestic + STock					
INFOI WELL APPROP. X					
OWNER USQS SCS					
LOCATION BEEN VERIFIED Yes		1			
JERMAN MARK AGENCY MBMG					
FIED					
T ABOVE LSO ft. DATE					
TH BELOW LSO ft					
VEL BELOW LSD ft					
w LSO 31.7 n. 6/02/82		-			
1229 (/)/22	-	1			
P. C 13.2 6/03/82					
NO. et 25 C 29/1 6/02/82		-			
NUMBER		-			
NUMBER		-			
M NUMBER		1			
LAB. NUMBER		-		SKETCH WAP	
NUMBER		<b>A</b>	1		
	20		La.	ン	
		H N	1		
NATER 18UGR IMRD	تلتك	۱۷ لند	7		-1
			MIK		Well
	1	NICOLUN.	1/0	1.	1
	U.	100041	C/4/	47.	*/_ C-43
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rm 182 (9/79)					
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## MONTANA BUREAU OF MINES AND GEOLOGY WELL-DATA SHEET

COUNTY CASCADE T. 2		R. 4 POFW SEC. 36 TRACT BAAC	
O I H O I	w.	UTM N E	
TOWN SUBDIVISION		BLOCKLOT	
OWNER'S NAME ROBERT VINING		ADDRESS R. ROUTE BUL 21606.F.	
	PHONE NUMBE	R 736-5260 YEAR	
ALT. LAND SURF. AT WELL MSL 3390 M.			
TOTAL DEPTH BELOW LSD /00 M.	INTERVAL (F	T.)	
PUMPING LEVEL BELOW LSD T.	FROM TO	DESCRIPTION	
STATIC WATER LEVEL BELOW LSD 20 ft.	PROM TO		
YIELD IN GALLONS PER MIN	25	TEP 301	
HOW TESTED & P. P. P. TIME (HR.)	5 19	Yellow Spirit at	
IF F, SHUT-IN PRESS. IN PSI	14 35	Vennifel s . E	
	31 44	PINK CHAIR	
GEOLOGICAL SOURCE OF H20 TUYESTIC UNDSIT.	44 50	PINE CHAIR VIOLENCE CC . 1 - 17	
	50 57	100 - 1. C. C. 1.110	
CASING DIA. 26 In. FROM R. TO R.	17 75	600 : 1011 7 ALZ HO	
in. FROM ft. TO ft.	75 79	32 5 Hr 12	
CASING TYPE	79 92	12 LA CANDITAL	
PERFORATED INTERVAL ft. TO ft.	192 97	HARD BLACK SHALE	
ft. TO ft.	17 100	can; chole	
ft. TO ft.		V	
PERFORATION DESC.			
PUMP SIZE (HP.) TYPE			
DATE WELL COMPLETED			
HOW DRILLED			
BY WHOM PAT BYRNE LIC. 35			
WELL USE DOMESTIC			
SOURCE OF INFO: WELL APPROP.			
DRILLER OWNER USGS SCS			
OTHER:			
HAS WELL LOCATION BEEN VERIFIED YES			
BY WHOM HERMAN MOORE AGENCY MAMG			
DATE VERIFIED			
MEAS. POINT ABOVE LSD ft. DATE			
TOTAL DEPTH BELOW LSD ft			
PUMPING LEVEL BELOW LSD ft.			
PUMPING LEVEL BELOW LSD 1. SWL* BELOW LSD 24.73 n. 5/27/82			
YIELD IN GPM			
WATER TEMP.°C 9,5 5/27/82			
SPECIFIC COND. at 25°C /336 5/27/82			
MBMG FILE NUMBER			
DNR FILE NUMBER			
WELL FORM NUMBER			
MBMG WQ LAB. NUMBER		SKETCH MAP	
SYS 2000 NUMBER			
OTHER:	36		
	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	633	
REMARKS: 010 well 160' WENT		(22/) (30%	
RAD DUE TO FE	Ge	er ber	
	7	the transmission of the	
	1 70	C-44	
•F = FLOWING	70.0	The state of the s	
MBMG Form 182 (9/79)		13 B-111NG TO.	

## MONTANA BUREAU OF MINES AND GEOLOGY WELL-DATA SHEET

COUNTY CASCADE T. 2	QINAS	R5 (0000	v SEC. 3/	TRACT CDAA
0 1 H 0 I	w.	UTM	N	Ε
TOWN SUBDIVISION _			BLOCK	LOT
OWNER'S NAME SENE GTTO JUHNS	Sol	ADDRESS	STAR RI	Good Costect
				AR
ALT. LAND SURF. AT WELL MIL 3400 11.				
TOTAL DEPTH BELOW LSD 11.	INTERVAL		DLOGIC LOG	
PUMPING LEVEL BELOW LSD			DESCRIPTION	DN
STATIC WATER LEVEL BELOW LSD 100 TL	FROM T	0		
YIELD IN GALLONS PER MIN.				
HOW TESTED TIME (HR.)				
IF F, SHUT-IN PRESS. IN PSI				
GEOLOGICAL SOURCE OF H20 - 110831WE				
- MHdison				
CASING DIA 6 In. FROM 0 1. TO 100 M.				
CASING TYPE (Tee/				
PERFORATED INTERVAL ft. TO ft.				
n. TO n.				
ft. TOft.				
PERFORATION DESC.				
PUMP SIZE (HP.) TYPE				
DATE WELL COMPLETED				
HOW ORILLED				
WELL USE DOINESTIC + STOCK				
SOURCE OF INFO! WELL APPROP.				
DRILLER OWNER USOS SCS				
OTHER:		Ì		
HAS WELL LOCATION BEEN VERIFIED YES				
BY WHOM HERMAN R MOUREAGENCY MBMG				
DATE VERIFIED 5/28/82				
MEAS, POINT ABOVE LSD ft. DATE				
TOTAL DEPTH BELOW LSD ft.			<u> </u>	
PUMPING LEVEL BELOW LSO 1. 5/28/82				
FU 5/1/102				
WATER TEMP. C 9.0 CASTS				
SPECIFIC COND. 41 23 C /698 6/18/82				
MBMG FILE NUMBER				
DNR FILE NUMBER				
WELL FORM NUMBER				
MBMG WQ LAB. NUMBER		1 7To 60	WAT FAILS	صا
SYS 2000 NUMBER		1	-(2)7)	Crost
OTHER!	31	AJ		o lifee cook
DEMARKS.		10	) - , - '	
REMARKS			# 1	
			1)	
			09	C-45
F = FLOWING		1	well,	Mir. or Konr
MBMG Form 182 (9/79)				

## MONTANA BUREAU OF MINES AND GEOLOGY WELL-DATA SHEET

COUNTY <u>LASCADE</u> T. 2		R	5 Borw	SEC. 31	TRACT DOUG
LAT N. LONG	w.		UTM	N	Ε
TOWN SUBDIVISION _				BLOCK	LOT
OWNER'S NAME GENE (OTTO) JOHN	الموك	well 2 is	ODRESS _	STAR RT	. SAND Coulec
	PHONE NU	MBER_		YE	AR
ALT. LAND SURF. AT WELL MSL 34/8 11.			LITHOL	ogic Log	
TOTAL DEPTH BELOW LSD 200 M.	INTERVA	L (FT.)			
PUMPING LEVEL BELOW LSD	FROM	то		DESCRIPTI	ON
YIELD IN GALLONS PER MIN.					
HOW TESTED TIME (HR.)					
GEOLOGICAL SOURCE OF H20 LIME STORE					
GEOLOGICAL SOURCE OF H20	-				
MADISON					
CASING DIA. 4 In. FROM ft. TO ft.					
CASING TYPE STEEL					
PERFORATED INTERVAL ft. TO ft.					
ft. TO ft.					
ft. TO ft.					
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED					
HOW DRILLED	-				
BY WHOM LIC					
WELL USE UNUSED					
SOURCE OF INFO! WELL APPROP.	-				
OTHER					
HAS WELL LOCATION BEEN VERIFIED Yes					
BY WHOM HERMAN MOOREAGENCY MB.MG					
DATE VERIFIED					
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSD ft					
PUMPING LEVEL BELOW LSD 11.  SWL* BELOW LSD 72.15 H. 5/28/82					
SWL BELOW LSD /2.15 n. 1/28/82					
YIELD IN OPM	-				
WATER TEMP. C					
SPECIFIC COND. at 25 C					
MBMQ FILE NUMBER		-			
ONR FILE NUMBER					
MBMG WQ LAB. NUMBER				SKETCH MAP	
SYS 2000 NUMBER		A	1		
OTHER:	31				
REMARKS: WATER WENT BAD		J N	7	227	
					RANCE
			. 1		To Harton,
*F * FLOWING			(nocy	ū	D C-46
MBMG Form 182 (9/79)		10	1	10	JOHNSONS RANKH

GROUNDWATER QUALITY LABORATORY ANALYSES



```
STATE MONTANA COUNTY CASCADE LATITUDE LONGITUDE 47823'01'N 111808'52'W SITE LOCATION 19N 5F 19*CAAD 01
       UTH COORDINATES Z N E
TOPOGRAPHIC MAP SOUTHFAST GREAT FALLS 7 1
GEOLOGIC SOURCE 330MDSN* * *
DRAINAGE BASIN BB LAND SU
                                                                        MEMG STIF
STATION ID
SAMPLE SOURCE
                                                                                               472301111085701
                                                                                              111.1.1.
                                                            LAND SURFACE ALTITUDE SUSTAINED YIELD
                                                                                               3480. FT 10
10 0 GPH
BUCKET/STOPWATCH
                                HENG*HRH
RGUISTI
20 JUN 62
10:45 HOURS
HENG*FNA
      AGENCY 1
           NCY ( SAMPLER
BOTTLE NUMBER
                                                                   YIELD HEAS HETHOD
                                                             TIELD BEAS OF THUD
TOTAL DEPTH OF WELL
ABOVE() OR BELOW GS
CASING DIAMETER
CASING TYPE
COMPLETION TYPE
       BUTTLE RUBBER
TATE SAMPLED
TIME SAMPLED
LAB - ANALYST
DATE ANALYZED
SAMPLE HANDLING
                                                                                               238. FT (R)
130. FT (R)
                                                                                               STEEL (H)
                                16 · JUL · 82
                                                                                                  *
        METHON SAMETAN
                                                              PERFORATION INTERVAL
                WATER USE DOMESTIC
           SAMPLING SITE RONALD GUISTE .5 MI SW OF CENTERVILLE
       GEOLOGIC SOURCE HADISON GROUP OR LIMESTONE
                                                                                                 MG/1.
                                                                                                             HLR/L
                                                HER/I.
                                  HG/!
                                                                                                 227.B
                                  113.
                                                                                  (HC03)
                                                                                                                3.77
      CALCIUM
                      (CA)
                                                   5.64 BICARBONATE
                                                                                                    2.8
                                   38.4
                                                          CARBONATE
                                                                                  (003)
      MAGNESIUM (HG)
                                                   3.16
                                                                                                                0.00
                                    13.1
                                                                                    (CL)
      SONIUH
                      (NA)
                                                   0.57
                                                           CHLORIDE
                                                                                                 312.
      POTASSIUM (K)
                                                   0.11 SULFATE
                                                                                   ($04)
                                                                                                                 6.50
                                                                                                    $.67
.53
                                                           NITRATE
                                                                                                                0.41
                                                                                  (AS N)
      IRON
                     (FE)
                                                           FLUDRIDE
      MANGANESE
                     (HH)
                                     <.001
                                                                                      (F)
                                                                                                                0,03
                                                           PHUSPHATE TOT (AS P)
      SILICA (SIO2)
                                     3.5
                                                                                                               10.78
                                                                       TOTAL ANIONS
                                                   5.48
         TOTAL CATIONS
         STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                     5.13
                                                                               (SIGHA)
                         LABORATORY PH
                                                     7.52
                                                                                                         440,22
                                                                 TOTAL HARDNESS AS CACO3
                                                 14.5 C TOTAL ALKALINITY AS CACO3
611.42 SODIUM ADSORPTION RATIO
728.02 RYZNAR STABILITY INDEX
                                                                                                          138.48
         FIELD WATER TEMPERATURE
   CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT
                                                                                                             6.82
                                                827.8 LANGLIER SATURATION INDEX
                                                                                                             0.35
 LAB SPEC.COND. (HICROHHOS/CH)
                                             VALUE
                                                                        PARAMETER
                                                                                                          VALUE
                                             76. F
7.53
                                                             CNDUCTVY+FIELD HICROHHOS
                                                                                                          714.
TEMPERATURE, AIR (C)
                                                            ALKALINITY FUD (AS CACO3)
                                                                                                         185.4
FIELD 2H
ALUMINUM, DISS (MG/L-AL)
SILVER, DISS (MG/L AS AG)
BORON, DISS (MG/L AS B)
CABMIUM, DISS (MG/L AS CD)
CHROMIUM, DISS (MG/L AS CD)
                                                                                                           < . 0.1
                                               <.003
                                                             NICKEL DISS (MG/L AS NI)
                                                            LEAD, DISS (MG/L AS PR)
STRONTIUM, DISS (MG/L AS TI)
TITANIUM DIS(MG/L AS TI)
VANADIUM, DISS (MG/L AS V)
TINC, DISS (MG/L AS ZN)
                                               <.002
                                                                                                             .05
                                                                                                             .25
                                               <.02
                                               .002
                                                 .008
                                                                                                             .007
                                                                                                              .17
COPPER, DISS (HG/L AS CU)
LITHIUM, DISS (HG/L AS LI)
                                                .013
                                                             ZIRCONIUM DISCHG/L AS ZR
                                                                                                              .011
                                                 .014
                                               <.02
MOLYBDENUM, DISS(MG/L-MO)
REMARKS: WATER CLEAR*TASTE AND SHELL OK*LIGHT BROWN STAIN ON FILTER
              OWNERS ADDRESS BOX 23 SAND COULEE BLOWING WELL
FU CA 130, HG 44.5 GIVES 10.8 HER CATIONS FOR -.183 SIGHA
      LAFI
EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEG/L = MILLIERUIVELENTS PER LITER, FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.
                                    GM
                                          NA
                                                $2
                                                       UI
                                                             OW
                                                                   FIN
                                                                         AT
                                                                                      OTHER
OTHER AVAILABLE DATA OTHER FILE NUMBERS:
                                            Y
```

PERCENT HEAZL (FOR PIPER PLOT) CL SO4 HCO3 CO3 0.8 52.8 36.4 0.0 CA MG 57.5 33.3 MG NA 1.1 6.0

COST:

PRINTED:

RY:

TE *RCS

27-HAY-83

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAW NUMBER: 8200490

F1730F V2 (11/3/81)

27 · JUL 82

PROJECT:

LAST EDIT DATE:

PROCESSING PROGRAM:

HONTANA BUREAU OF HINES AND GEOLOGY WATER QUALITY ANALYSIS BUTTE, HONTANA 59701 (406)496-4101 LAB NO. 8200491 STATE LATITUDE-LONGITUDE COUNTY CASCADE MONTANA 47019'09'N 111009'14'N SITE LOCATION 18N SE 18*BBBA MANG SITE N STOCKETT 7 1/2' UTH COURDINATES DRAINAGE BASIN AGENCY + SAMPLER BOTTLE NUMBER 10 471909111091401 * SAMPLE SOURCE SPRING LAND SURFACE ALTITUDE SUSTAINED YIELD BB 3875. FT < 10 HBHG*WJB YIELD HEAS HETHOD SHIRLEY 22-JUN-82 12:15 HOURS HBMG*FNA DATE SAMPLED TIME SAMPLED LAR + ANALYST DATE ANALYZED SAMPLE HANDLING TOTAL DEPTH OF WELL SWL ABOVE(-) OR BELOW OS FLOWING CASING DIAMETER CASING TYPE 16-JUL-82 PERFORATION INTERVAL HETHOD SAMPLED WATER USE BOHESTIC SAMPLING SITE SHIRLEY, WILLIAM*2,5 HI UP COTTONWOOD CK GEGLOGIC SOURCE HG/I. MG/I.. HEQ/L HER/L 3.10 BICARBONATE 2.67 CARBONATE 0.44 CHLORIDE 32.5 10.1 2.8 (RC03) 300. 4.92 CALCIUM (CA) 3.8 MAGNESIUH (HG) (003) SOPIUM (CL) 0.11 (NA) 27.6 0.57 (\$04) POTASSIUM (K) 0.07 SULFATE IRON (FE) MANGANESE (MN) <.002 <.001 NITRATE (AS N) 10.1 (F) FLUORIDE .36 SILICA (SIG2) 9.9 PHOSPHATE TOT (AS P) TOTAL CATIONS 6.28 TOTAL ANIONS 6.34 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGNA) 7.55 TOTAL HARDNESS AS CACO3 14.2 C TOTAL ALKALINITY AS CACO3 LABORATORY PH 288.83 FIELD WATER TEMPERATURE 246.05 307.04 SODIUM ADSORPTION RATIO 459.26 RYZNAR STABILITY INDEX CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT 0.26 7.08 569.6 LANGILIER SATURATION INDEX LAB SPEC.COND. (HICROHHOS/CH) VALUE PARAMETER VALUE PARAMETER CNDUCTVY, FIELD HICROMHOS ALKALINITY, FLD (AS CACO3) NICKEL, DISS (HG/L AS NI) LEAD, DISS (HG/L AS FB) STRONTIUM, DISS (HG/L AS TI) VANADIUM, DISS (HG/L AS TI) 71. F 3.75 576. TEMPERATURE, AIR (C) 250. FIELD PH <.01 ALUMINUM, DISS (MG/L-AL) SILVER,DISS (MG/L AS AG) DORON ,DISS (MG/L AS B) CADMIUM,DISS(MG/L AS CD) (6.03 <.002 <.04 .27 <.02

REMARKS: FROM STOCKETT* FILTER CLEAN* WATER CLEAR WILLIAM SHIRLEY* RT 36 STOCKETT HT, 59480 ARTESIAN SPRING

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L MILLIEQUIVELENTS PER LITER. FT = FEET, MT = METERS. (H) = MEASURED, (E) = ESTIMATED, (R) = REPORTED, TR = TOTAL RECOVERABLE. TOT = TOTAL.

PW 52 WI OW AT DIRER WA QW

ZINC/DISS (MG/L AS ZN) ZIRCONTUM DIS(MG/L AS ZR

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

CADMIUM, DISS(MG/L AS CD) CHRONIUM, DISS (MG/L-CR)

COPPER DISS (MG/L AS CU) LITHIUM DISS (MG/L AS LI)

MOLYRDENUM, DISSING/L-MO)

COST: PROJECT: 29-JUL-82 F1730F V2 (11/3/81) BY: TP *BCS LAST EDIT DATE: PRINTEDE 27-HAY-83 PROCESSING PROGRAM:

<.002

<.002

.006

1.02

.007

PERCENT HEAVE (FOR PIPER PLOT) NA K CL 504 HC03 C03 7.0 1.1 1.7 10.3 87.6 0.0 CA MG 7.0 49.3 42.5

NOTE: TH CORRESPONDENCE, PLEASE REFER TO LAR NUMBER: 8200491 < .001

<.003

.047

```
STATE MONTANA COUNTY CASCADE LATITUDE-LONGITUDE 47D23'50'N 110D10'35'N SITE LOCATION 19N 04E 14 DADA
                                                                                         COUNTY CASCADE
                                                               HRMG SITE
ALLS 7 1 STATION ID 472350110103501

* SAMPLE SOURCE WELL
LAND SURFACE ALTITUDE 3680, FI 10
        UTH COORDINATES
        TOPOGRAPHIC MAP SOUTHFAST GREAT FALLS 7 1
GFOLOGIC SOURCE 217KOTH* * *
DRAINAGE BASIN BR LAND SUB
      AGENCY & SAMPLER DOITLE NUMBER
                                                                          SUSTAINED YIELD
ELD HEAS HELHOD
                                  HRMG*WJB
                                   SCWU*W2
                                                                       YIELD HEAS
                                                                  TOTAL DEPIH OF WELL ABOVE(-) OR BLIOW GS CASING PIAHETER CASING TYPE COMPLETION TYPE PERFORATION INTERVAL
                                  17 JUN-32
14:10 HOURS
HBHG*FNA
                    SAHELED
             DATE
                                                                                                        710.
                                                                                                                       (R)
                                                                                                                 FT (R)
           TIME SAMPLED
LAR : ANALYST
DATE ANALYZED
                                                                                                     150. F
3 IN (R)
                                                           SWL
                                                                                                    STEFI.
                                  07-JUL-82
        SAMPLE HANDLING
                                                                                                    01*
                                  PUMPED
         HETHOD SAMPLED PUMPED WATER USE PUBLIC SUPELY
        SAMPLING SITE SAND COULER WIR USERS BENCH W ARV SAND COU
GEOLOGIC SOURCE KOOTENAL FORMATION
                                                                                                       MG/I
                                                                                                                   MER/L
                                    MG/1.
                                                     2.58 BICARBONATE
5.75 CARBONATE
0.75 CHLORIDE
                                     51.7
      CALCIUM
                       (CA)
                                                                                      (HC03)
                                                                                                       444.
                                                                                                                      7.28
                                      69.9
                                                                                                        0.
      MAGNESIUM (MG)
                                                                                       (003)
                                                                                                        12.3
      SODIUM
                       (NA)
                                                                                         (CL)
                                                                                                                       0.35
                                                      0.07 SULFATE
                                                                                        (SO4)
                                                                                                                       1.48
      POTASSIUM (K)
                                       .011
                                                      0.00 HITRATE
                                                                                      (AS N)
      IRON
                      (FE)
                                                                                                                       0.09
      MANGANESE (HN)
SILIGA (SIO2)
                                         .024
                                                                                                          1.1
                                                      0,00 FLUORIDE
                                                                                          (F)
                                                                                                                       0.06
                                        7.5
                                                               PHOSPHATE TOT (AS P)
         TOTAL CATIONS
                                                      2.15
                                                                            TOTAL ANIONS
         STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA)
                                                                                                       0,39
                                                        7.65
                                                                     TOTAL HARDNESS AS CACO3
                                                                                                                 416.80
                          LABORATORY PH
 FIELD WATER TEMPERATURE
CALCULATED DISSOLVED SOLIDS
SUM OF DISS. CONSTITUENT
LAB SPEC.COND.(MICROMHOS/CM)
                                                    15. C TOTAL ALNALINITY AS CACO3
453.57 SODIUM ADSORPTION RATIO
678.04 RYZNAR STABILITY INDEX
                                                                                                                 364.16
                                                                                                                0.37
                                                   789.2 LANGLIER SATURATION THREX
                                                                                                                  0.46
           PARAMETER
                                                VALUE.
                                                                                                                VALUE
                                                86. F
7.40
TEMPERATURE, AIR (C)
                                                                CHDUCTVY, FIELD HICRDHHOS
                                                                                                                833.
                                                                CNDUCTVY; FIELD MIGROWHOS ALKALINITY; FLD (AS CACO3) NICKEL; DISS (HG/L AS NI) LEAD; DISS (HG/L AS PB) STRONTIUM; DISS (HG/L AS TI) VANADIUM; DISS (HG/L AS V) ZINC; DISS (HG/L AS ZN)
                                                                                                               738.
FISUR 28
                                                                                                               <.01
ALUMINUM, DISS (MG/L-AL)
SILVER, DISS (MG/L AS AG)
DORON, DISS (MG/L AS R)
                                                 <.03
                                                   .05
                                                                                                                   .52
CADMIUM, DISS(MG/L AS CD)
CHRONIUM, DISS (MG/L-CR)
                                                 <.002
                                                                                                                  .001
                                                 <.002
                                                                                                                 < .001
COPPER, DISS (MG/L AS CU)
LITHIUM, DISS(MG/L AS LI)
                                                  <.002
                                                  .042
                                                                ZIRCONIUM DISCHG/L AS ZR
                                                                                                                  <.003
```

REMARKS: FILTER BROWN SILT * WATER CLOUDY JOHN G. MITTAL PRES.

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MER/L = MILLIERUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED. (E) = ESTIMATED. (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

GH WA 52 WI OW PN AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

MOLYBRENUM, DISS(MG/L-MO)

COST: PROJECT:

LAST EDIT DATE: 23-JUL-82 COOTHS PROGRAM: F1730P V2 (11/3/81) BY: TP *CHT PROCESSING PROGRAM: PRINTEDE 27 - MAY -- 83

.06

PERCENT MEQUL (FOR PIPER PLOT) CL S04 HC03 3.8 16.2 77.7 CA 0.03 HG NA 28.2 62.8 3.2 0.3 0.0

### WATER QUALITY ANALYSIS LAB NO. 8200493

```
STATE HONTANA
LATITUDE-LONGITUDE 47024'1
                                                                                           COUNTY CASCADE
                                  47024'14'N 110009'17'W SITE LOCATION 19N 4E 13 AADD T N E HBHG SITE SOUTHEAST GREAT FALLS 7 1 STATION ID 472414110091701 330HDSN* * SAMPLE SOURCE WELL
                                                                 HBHG SITE
ALLS 7 1 STATION ID
* SAMPLE SOURCE
LAND SURFACE ALTITUDE
SUSTAINED YIELD
        UTH COORDINATES
        TOPOGRAPHIC MAP
GEOLOGIC SOURCE
DRAINAGE BASIN
                                                                                                         3440.
                                                                                                                    FT
                                   F: F:
                                                                                                                         < 10
      AGENCY + SAMPLER
BOTTLE NUMBER
                                                                                                            10.0 GPM
                                   HBHG*HRM
                                                                        YIELD HEAS HETHOD BUCKET/STOPWATCH
                                   CHENSTH
        TOTTLE NUMBER CHENSIN
DATE SAMPLED 22-JUN-82
TIME SAMPLED 10:00 HOU
LAR & ANALYST MRMG*FNA
DATE ANALYZED 07-JUL-82
SAMPLE HANDLING
                                                                  TOTAL BEPTH OF WELL
ABOVE(-) OR BELOW GS
CASING DIAMETER
                                  22-JUN-82
10100 HOURS
HBMG*FNA
                                                                                                          185, FT (R)
121, FT (R)
                                                                                              WELL
                                                            SWL
                                                                                                           121.
                                                                                                             (H) NI
                                                                            CASING TYPE
                                                                                                       STEEL
                                                                                                          *
         METHOD SAMPLED PUMPED
                                                                   PERFORATION INTERVAL
                  WATER USE DOMESTIC
           SAMPLING SITE CHARLES ENTSHINGER*TOWN OF NUMBER SEVEN
        GEOLOGIC SOURCE HADISON GROUP OR LIHESTONE
                                    MG/I.
                                                    HER/L
                                                                                                         HGZI.
                                                                                                                      HEQ/L
                                                       3.27 BICARBONATE
2.36 CARBONATE
0.50 CHLORIDE
                                      77.6
                                                                                                         246.9
                                                                                        (HC03)
      CALCIUN
                        (CA)
                                                                                                                         4.05
                                                                                         (CD3)
(CL)
                                                                                                             .0
      MAGNESIUH (HG)
                                                                                                                         0.11
2.75
0.06
                                                                                                            4.0
      SODIUH
                        (NA)
                                       11.4
                                                                                                         132.
                                                                SULFATE
      POTASSIUM
                         (K)
                                       2.5
                                                       0.06
                                                                                          (S04)
                                        <.002
                                                                                        (AS N)
      IRON
                        (FE)
                                                                                                              . 44
      MANGANESE (HN)
                                                                FLUORIDE
                                                                                                                          0.02
                                        < .001
                                                                                             (F)
      STLUCA (SIO2)
                                                                PHOSPHATE TOT (AS P)
                                       12.3
                                                                                                                          7.00
                                                       6.85
                                                                             TOTAL ANIONS
          TOTAL CATIONS
         STANBARD DEVIATION OF ANION-CATION BALANCE (SIGNA)
                                                                                                              0.47
                           LABORATORY PH
                                                        7.94
                                                                      TOTAL HARDNESS AS CACO3
                                                                                                                   316.89
                                                     16. C TOTAL ALKALINITY AS CACO3
353.48 SODIUM ADSORPTION RATIO
518.75 RYZNAR STABILITY INDEX
                                                                                                                   202.50
         FIELD NATER TEMPERATURE
  CALCULATED DISSOLVED SOLIDS
                                                                                                                    0.28
                                                                                                                      6.65
                                                     596.3
                                                                   LANGLIER SATURATION INDEX
                                                                                                                      0.65
 LAB SPEC.COND. (HICROHHDS/CH)
                                                 VALUE
                                                                                                                   VALUE
           PARAMETER
                                                                              PARAHETER
                                                 75. F
7.27
<.03
TEMPERATURE, AIR (C)
                                                                  CHDUCTVY, FIELD HICROHHOS
                                                                                                                   620.
                                                                  ALKALINITY, FLD (AS CACO3)
NICKEL, DISS (HG/L AS NI)
LEAD, DISS (HG/L AS PB)
                                                                                                                 412.4
FIELD PH
ALUMINUM, DISS (HG/L-AL)
SILVER,DISS (HG/L AS AG)
BORON,DISS (HG/L AS B)
                                                                                                                    <.01
                                                                 NICKEL, DISS (MG/L AS NI)
LEAD, DISS (MG/L AS PB)
STRONTIUM, DISS (MG/L AS TI)
TITANIUM DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS V)
ZINC, DISS (MG/L AS ZN)
ZIRCONIUM DISS (MG/L AS ZR
                                                  <.005
                                                                                                                     <.04
                                                  <.002
                                                                                                                     72
<.001
CARNIUM, DISS (HG/L AS CD)
CHROMIUM, DISS (HG/L-CR)
COPPER, DISS (HG/L AS CU)
LITHIUM, DISS (HG/L AS LI)
                                                                                                                    <.001
                                                   .004
                                                                                                                      .043
                                                                                                                     <.003
                                                    .016
```

REHARKS: WATER CLEAR *TASTE AND SMELL OF SILTY FILTER OWNERS ADDRESS SAND COULSE

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L HILLIEQUIVELENTS PER LITER, FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

OU WA SO WI OW PW AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

HOLYBDENUM, DISS(MG/L-HO)

PROJECT: COST:
LAST EDIT DATE: 23-JUL-82 BY: TP *CHT
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-MAY-83

<.02

PERCENT HEQ/L (FOR PIPER PLOT)
CA MG NA K CL 804 HC03 C03
57.6 34.3 7.2 0.9 1.6 39.8 58.6 0.0

## WATER QUALITY ANALYSIS 1 AB NO. 8280474

```
HATE HONTANA
                                                                                              COUNTY CASCADE
   LATITUDE-LONGITUDE 47018'54'N 111011'04'W STIF LOCATION 18N 41 14 ACED
        UTH COORDINATES 7 N
TOPOGRAPHIC HAP STOCKETT 7 1/
GEOLOGIC SOURCE 217KOTN*
                                                                   HRMG SITE
STATION IN 471854111110401
# SAMPLE COURCE SPRING
LAND SURFACE ALTITUDE 3880, EL 10
        GENCY | SAMPLER HIS
DOTTLE NUMBER R.)
                                                                                                           3880, F1
2.6 GFm
                                    H3HG*HRH
                                                                               SUSTAINED YIELD
                                                                     YIELD HEAS METHOD RUCKTIZSTOPWATCH
TOTAL DEPTH OF WELL
AROVE(-) OR BELOW GS
CASING DIAMETER
             DATE SAMPLED 21 JUN-82
TIME SAMPLED 10:40 HOURS
        LAB + ANALYST HRHG*FNA
DATE ANALYZED 16-JUL-82
SAMPLE HANDLING
METHOD SAMPLED PUMPED
                                                                     CASING TYPE
COMPLETION TYPE
PERFORATION INTERVAL
                   WATER USE DOMESTIC
        SAMPLING SITE RICK YUREK*, 25 HI N OF GIFFEN SPRING GEOLOGIC SOURCE KOOTENAL FORMATION
                                                                                                                          HIR, L
                                                                                                            HG/I
                                                      KER/I
                                      HG/I
                                                         2.45 RICARBONATI
3.20 CARBONATI
0.37 CHLORIDE
                                       47.3
                                                                                           (HC03)
                                                                                                            321.
                                                                                                                             5.26
                        (CA)
                                                                 BICARBONATE
      CALCIUM
                                                                                                               1.6
      MAGNESTUM (HG)
SODIUM (NA)
                                                                  CARBONATE
                                                                                             (003)
                                        38.9
                                                                                                                             0.50
                                         8.4
                                                                                              (CL)
                                                                                                              24.0
                                                                                            (504)
                        (K)
                                          2.4
                                                                 SULFATE
      POTASSIUM
                                                         0.06
                                          1.002
                                                                  NITRATE
                                                                                           (AS N)
       IRON
                                                                                                (F)
      MANGANESE (HN)
                                                                  FLUORTIF
                                                                                                                 .58
                                                                                                                             0.03
                                           .001
      SILICA (SIO2)
                                                                  PHOSPHALE TOT (AS F)
          TOTAL CATIONS
                                                         6.09
                                                                                TOTAL ANTONS
                                                                                                                             0.12
          STANDARD DEVIATION OF ANION-CATION BALANCE (SIGHA)
                                                                                                                0 14
                                                                                                                      283.21 263.27 0.22 7.16
                                                           7.61
                                                                         TOTAL HARDNESS AS CACO3
                           LARGRATORY PH
                                                       10.5 C TOTAL ALKALINITY AS CACOZ
295.22 SONTUM ADSORPTION RATIO
458.09 RYZNAR STABILITY INDEX
537.4 LANGLIER SATURATION INDEX
          FIELD WATER TEMPERATURE
 CALCULATER DISSOLVED SOLTES
SUM OF DISS. CONSTITUENT
LAB SPEC.COND. (MICROMHOS/CH)
                                                                                                                          0.22
                                                                                                                      VALUE
                                                  VALUE
                                                                                PARAMETER
            PARAMETER
                                                                   CHBUCTVY/FIELD HICROHHOS
ALKALINITY-FLB(AS CACO3)
NICKEL-BISS (HG/L AS NI)
LEAD-BISS (HG/L AS PB)
                                                  75. F
6.82
                                                                                                                      542.
TEMPERATURE, ATR (C)
                                                                                                                     7,57.
FIELD PH
                                                    <.03
                                                                                                                      .01
ALDMINUH, DISS (HG/L-AL)
SILVER, DISS (HG/L AS AG)
DORDN , DISS (HG/L AS E)
CADHIUM, RISS (HG/L AS CD)
                                                                   TITATIONS (HG/L AS FE)
TITATION DISS (HG/L AS TI)
VANADION DISS (HG/L AS V)
ZINCIDISS (HG/L AS ZN)
ZIRCONION DISCHG/L AS ZR
                                                                                                                        .30
                                                     .07
                                                                                                                       1.001
CHROHIUM, DISS (HG/L-CR)
                                                    <.002
COPPER, DISS (MG/L AS CU)
LITHIUH, DISS(MG/L AS LI)
                                                                                                                         .066
                                                    <.002
```

REMARKS: WATER CLOUDY WITH RUBBLES*TASTE & SHELL ON*LIGHT BROWN. LAIN ON FULLER OWNERS ADDRESS EVANS RT STOCKETT

EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, HEG/L = HILLIEQUIVELENTS PER LITER, ET = EEET, HT = HETERS. (H) = HEASURED. (F) = ESTIMATED. (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

GW WA 52 WI OW PW AT BIHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

HOLYBBENUH, BISS (HG/I -HO)

COST: PROJECT: LAST EDIT DATE: BY: TF *RCS 30 - JUL - 82 PROCESSING PROGRAM: F1730P V2 (11/3/81) 27-MAY-83 PRINTED:

.005

PERCENT HERM (FOR PIPER PLOT) \$04 HE03 C03 8.6 70.6 0.0 CA MG 40.4 52.5 CI. NA 0.8 5.0 1.0

NOTE: IN CORRESPONDENCE, PLEASE RECER TO LAB NUMBER: 8200494

1.003

HONTANA BUREAU OF HINES AND GEOLOGY BUTTE, MONTANA 59701 (406)496-4101

- WATER QUALITY ANALYSIS LAB NO. 8200495

COUNTY CASCADE STATE MONTANA SITE LOCATION 19N 4E 23*CCDD 47D22'42"N 111D11'30"N LATITUDE - LONGITUDE HBMG SITE UTH COORBINATES N HRMG SITE

ALLS 7 1 STATION ID 472242111113001

* SAMPLE SOURCE WELL
LAND SURFACE ALLTITUDE 3680. FI < 10
SUSTAINED YIELD 8.6 GPH
YIELD HEAS HETHOD BUCKET/STOPMATCH SOUTHEAST GREAT FALLS 7 1 TOPOGRAPHIC MAP GEOLOGIC SOURCE IRAINAGE BASIN AGENCY + SAMPLER * * NCY + SAMPLER BOTTLE NUMBER SUSTAINED
YIELD HEAS METHOD
TOTAL DEPTH OF WELL
ABOVE(-) OR BELOW GS
CASING DIAMETER AEMG*WJB OTTLE NUMBER LAROCOU BATE SAMPLED TIME SAMPLED : HO 100. 0. HOURS SWI. LAR + ANALYST DATE ANALYZED SAMPLE HANDLING HENG*FNA CASING TYPE
COMPLETION TYPE
PERFORATION INTERVAL 16-JUL-82 * METHOD SAMPLED PUBBED WATER USE DOMESTIC SAMPLING SITE LAROCRUE, H*TURNOFF 1.2HI SW OF SAME COULEE GEOLOGIC SOURCE HG/I. HER/L MG/I.. HER/L 407. 31.5 4,07 BICARBONATE (HC03) 6.67 (CA) CALCIUM 3.92 CARBONATE . 0 MAGNESIUM (MG) 47.7 (003) 14.7 4.5 65.5 5.92 0.13 1.36 0.42 CHLORIDE (CI_) 0.54 SOUTUR (NA) (904) POTASSIUM 0.07 SULFATE (K) <.002 NITRATE (FE) (AS N) IRON (F) (F) 0.04 MANGANESE 0.00 FILUDRIDE .85 (MN) .12 PROSPHATE TOT (AS SILICA (SIG2) 8.5 8.71 TOTAL ANIONS 8.63 TOTAL CATIONS STANDARD DEVIATION OF ANION-CATION BALANCE ..0.35 (SIGMA) 355,84 TOTAL HARDNESS AS CACO3 7.51 LABORATORY PH FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS TOTAL ALKALINITY AS CACO3 333.81 432.68 637.19 766.5 SODIUM ADSORPTION RATIO 0.32 SUM OF DISS. CONSTITUENT RYZNAR STABILITY INDEX LANGLIER SATURATION INDEX 0.44 LAR SPEC.COND. (MICROMHOS/CM) VALUE PARAMETER VALUE PARAMETER CNDUCTYY, FIELD HICROMHOS ALKALINITY, FLD (AS CACO3) NICKEL, DISS (MG/L AS NI) LEAD, DISS (MG/L AS PD) 755. TEMPERATURE, AIR (C) 63. 347. 7.39 FIELD PH <.03 <.01 ALUMINUM, DISS (MG/L-AL) STLVER, DISS (HG/L AS AG) BORON , DISS (HG/L AS B) CADHIUH, DISS(HG/L AS CD) <.002 0.04 STRONTIUM, DISS (MGZL -SR) .35 .04 <.002 <.003 TITANIUM DISCHG/L AS TI)
VANADIUM, DISSCHG/L AS V)
ZINC, DISS (HG/L AS ZN) < .001

REMARKS: FILTER CLEAN*NATER CLEAR HARVEY LAROCQUE*SAND COULEE, MT

EXPLANATION: MG/L = HILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MER/L MILLIEQUIVELENTS PER LITER. FT = FEET, MT = METERS. (H) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

> BTHER GM WA 25 WI 02 多日 AT

ZINC, DISS

ZIRCONIUH DISCHG/L AS ZR

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

CHRONIUM, DISS (NG/L-CR) COPPER,DISS (NG/L AS CU) LITHIUM,DISS(NG/L AS LI)

MOLYBDENUM, DISS(MG/L-MO)

COST: PROJECT: LAST EDIT DATE: PROCESSING PROGRAM: 30-JUL-82 F1730P V2 (11/3/81) TP *BCS DY: 27-HAY-83 PRINTED:

.023 < .02

PERCENT MEGAL (FOR PIPER PLOT) K 0.7 C1. S04 HC03 003 CA HG NA 1.6 16.7 81.7 46,7 45.1 7.3 0.0

IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8200495 NOTE:

<.001

.013 < .003

```
STATE BONTANA
LATITUDE-LONGITUDE 47023/02*N 111008/52*W
                                                                                        COUNTY CASCADE
                                                                            STIF LOCATION 1SN 51 15*CAAD 01
       UTH COORDINATES
                                                               LLS 7 1 STATION UN

* SOMPLE SOURCE

LAND SURFACE ALTITUDE
        TOPOGRAPHIC HAP
GEOLOGIC SOURCE
DRAINAGE BASIN
                                  SOUTHEAST GREAT FALLS 7 1
                                                                                                   4/2302111085,01
                                  330HBSN*
                                                                                                   WILL
                                                          2
                                                                                                   35 0. 11 0
                                  E.F.
                                                                SUSTAINED YITLD
YIELD HEAS HETHOR
TOTAL DEPTH OF WELL
ABOVE(+) OR BELOW 65
CASING DIAHETER
      AGENCY & SAMPLER BOTTLE NUMBER
                                                                                                   13.8 GFH
FUCLET/STOPWATCH
                                 HBHG ★HRH
BRIANGU
        BOTTLE NUMBER
DATE SAMPLED
TIME SAMPLED
LAR + ANALYST
DATE ANALYZED
SAMPLE HANDLING
METHOD SAMPLED
                                  20 - JUN - 82
                                                                                                     770. FT (R)
176.90 FT (R
                                 18:45 HOURS
                                                          SWL
                                                                                                          MI
                                                                         CASING TYPE
CONCLETION TYPE
                                  16-301-82
                                                                                                   STEEL
                                                                                                      *
                                 PHAPED
                                                                 PERFORATION INTERVAL
                 WATER USE DOMESTIC
       CAMPLING SITE RRIAN GUISTI .5 HI SW OF CENTERVILLE GEOLOGIC SOURCE MADISON GROUP OR LIMESTONE
                                                                                                                  HE OZL
                                                                                                     MG/1
                                   MG/L
                                                  HER/L
                                                     4.48 RICARRONATE
                                                                                                     215.7
                                     37.8
      CALCIUN
                      (CA)
                                                                                     (HCO3)
                                                                                                                    3.54
                                     42.4
                                                                                      (CO3)
(CL)
(SO4)
                                                                                                     3.3
                                                     3.49
                                                             CARBONATE
      MAGNESTUM (MG)
                                                                                                                     0.00
                                                             CHLORIBE
                      (NA)
                                                      0.44
      SODIUM
                                                                                                     228.
1.55
                                                                                                                    4.75
                                       3.6
                                                     0.09
      POTASSIUM
                        (人)
                                       <.001
<.001
                                                                                     (AS N)
                                                              NITRATE
      IRON
                      (FE)
      HANGANESE (HN)
                                                                                                         . 41
                                                                                                                     0.02
                                                              FLUORIDE
                                                                                          (F)
                                     12.4
      SILICA (SIO2)
                                                              PHOSPHATE TOT (AS P)
         TOTAL CATIONS
                                                     8.51
                                                                           TOTAL ANIONS
                                                                                                                     8.65
         STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                 (SIGHA)
                                                                                                        0 63
                          LABORATORY PH
                                                       7.44
                                                                 TOTAL HARDNESS AS CACOS
                                                                                                             398.75
                                                   12. C TOTAL ALKALINITY AS CACO3
459.92 SODIUM ADSORPTION RATIO
609.36 RYZNAR STABILITY INDEX
   FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS
                                                                                                              176.71
                                                               SODIUM ADSORPTION RATIO
RYZNAR STABILITY INDEX
LANGLIER SATURATION INDEX
                                                                                                                  0.22
 SUM OF DISS. CONSTITUENT
LAB SPEC.COND. (MICROHHOS/CH)
                                                                                                                  7.10
                                                                                                                  0.14
                                                   741.6
                                               VALUE
                                                               PARABETER CHRUCTVY:FIELD BICROHHOS
                                                                                                               VAL UC
           PARAMETER
TEMPERATURE, AIR (C)
                                                                                                             182.8
                                               82. F
7.00
                                                               ALKALINITY FUD (AS CACO3)
FIELD PH
                                                               ALRALIMITY FUNCAS CHEUS, NICKEL JUSS (HGZL AS NI) LEAD JUSS (HGZL AS PB) STRONTIUM JUSS (HGZL AS TI) VANADIUM JUSS (HGZL AS V) ZINC JUSS (HGZL AS ZN)
ALUMINUM, DISS (MG/L-AL)
SILVER, DISS (MG/L AS AG)
BORON, DISS (MG/L AS B)
CADMIUM, DISS (MG/L AS CD)
                                                                                                              .01
                                                 <.03
<.000
                                                                                                                  . 04
                                                  .05
                                                                                                                 ,56
                                                                                                                -.001
                                                 <.001
CHROMIUM, DISS (MG/L GR)
COPPER, DISS (MG/L AS CU)
LITHIUM, DISS (MG/L AS LI)
                                                 .007
                                                                                                                  . 24
                                                                ZIRCONIUM DISCHG/L AS ZR
                                                                                                                1.003
                                                  .013
MOLYBDENUM, DISS(MG/L-HO)
                                                 <.02
REHARKS: WATER CLEAR * TASTE % SHELL OK * CLEAN FILTER OWNERS ADDRESS STAR RT STOCKETT
```

EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, HER/L = HILLIFOUTVELENTS PER LITER. FT = FFET, HT = HETERS. (H) = HEASURED, (F) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE, TOT = TOTAL .

> WA \$2 IJ T ០ម OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: LAST EDIT DATE: 30 JUL 02 PROCESSING PROGRAM: F1730F V2 (11/3/81) TF *RCS 27 HAY-83 PRINTEDI

> PERCENT HEQUL (FOR PIPER PLOT) CI 504 HC03 MG NA 0.03 CA -K52.7 41.0 1.1 56.7 42.2 0.0

MONTANA BUREAU OF MINES AND GEOLOGY BUTTE, MONTANA 59701 (406)496-4101

WATER QUALITY ANALYSIS LAB NO. 8200497

```
STATE MONTANA
LATITUDE-LONGITUDE 47D24/05*N 111D09/51*W
                                                                                       COUNTY CASCADE
                                                                           SITE LOCATION 19N 4E 13 ACCE
      UTH COORDINATES
                                      N
                                                                                  HBHG SITE
                                                              LLS 7 1 STATION ID 472405111095101

* SAMPLE SOURCE WELL
LAND SURFACE ALTITUDE 3460. FT < 10
SUSTAINED YIELD 372 GPH
                                 SOUTHEAST GREAT
      TOPOGRAPHIC
                         HAP
                                                          FALLS 7
        EOLOGIC SOURCE
DRAINAGE BASIN
      GEOLOGIC
                                 330H0SN*
                                                         *
    DRAINAGE BASIN BE
AGENCY + SAMPLER MBMG*WUB
DOTTLE NUMBER GRAVULA
DATE SAMPLED 21-JUN-02
TIME SAMPLED 10:40 HOURS
LAB + ANALYST HBMG*FNA
DATE ANALYZED 14-JUL-02
SAMPLE HANDLING
METHOD SAMPLED PUMPED
WATER USE DOMESTIC
                                                                                                  3460. FT < 10
3.2 GPM
BUCKET/STOPWATCH
328. FT (R)
                                FEE
                                                         SUSTAINSU TIELD
YIELD HEAS HETHOD BUC
TOTAL DEPTH OF WELL 3
SWL ABOVE(-) OR BELOW GS 1
CASING DIAMETER 3
CASING TYPE STE
COMPLETION TYPE 01*
                                                                                                              FT (R)
FT (R)
                                                                                                      165.
                                                                                                  STEEL
                                                                PERFORATION INTERVAL
                WATER USE DOMESTIC
      SAMPLING SITE KAVULLA, GEORGE* SAND COULEE, HT GEOLOGIC SOURCE HADISON GROUP OR LIMESTONE
                                  MG/I
                                                 HERZI.
                                                                                                    MG/L
                                                                                                                 HER/L
                                                    5.54 BICARBONATE
                                                                                    (R003)
    CALCIUM
                     (CA)
                                  111.
                                                                                                    286.
                                                                                                                    4.69
                                                                                                       9.7
    MAGNESIUM
                    (MG)
                                                    3.65
                                                            CARBONATE
                                   44.4
                                                                                     (003)
                                                    0.59
                                                            CHLORIDE
                                                                                                                    0.27
    SOBIUM
                     (AM)
                                    13.6
                                                                                       (CL)
                                                                                                    236.
                                                                                                                    4.91
    POTASSIUM
                       (K)
                                     3.2
                                                    0.08
                                                            SULFATE
                                                                                      (904)
                                      .007
                                                                                                      1.07
                                                    0,00 NITRATE
                                                                                    (AS N)
                                                                                                                    0.03
    TRON
                     (FE)
    MANGANESE (MN)
                                       .004
                                                    0.00 FLUORIDE
                                                                                         (F)
                                                                                                        .57
                                                                                                                    0.03
    SILICA (SIO2)
                                    12.3
                                                            PHUSPHATE TOT (AS P)
        TOTAL CATIONS
                                                    9.87
                                                                         TOTAL ANIONS
                                                                                                                     9.98
        STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                         0.46
                                                                                 (SIGHA)
                        LABORATORY PH
                                                      7.15
                                                                   TOTAL HARDNESS AS CACO3
                                                                                                              459.92
FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT
                                                                                                              234.57
                                                                TOTAL ALKALINITY AS
SODIUM ADSORPTION
RYZNAR STABILITY
                                                                                                CACOS
                                                  572.74
717.85
                                                                                                RATIO
                                                                                                INDEX
                                                                LANGLIER SATURATION INDEX
LAB SPEC.COND. (MICROMHOS/CH)
                                                  846.1
                                                                                                                0.07
```

PARAMETER TEMPERATURE, AIR (C) PARAMETER VALUE VALUE 75. F 6.38 CNDUCTVY, FIELD HICROPHOS 633. ALKALINITY, FLD (AS CACO3) NICKEL, DISS (MG/L AS NI) 245. FIRED PH .03 DISS (HG/L-AL) ALUKIRUH, 0.01 SILVER, DISS (HG/L AS AG) BORON, DISS (HG/L AS E) CADHIUH, DISS (HG/L AS CD) < .002 LEAD DISS (HG/L AS PB) .06 .07 (MBZL-SR) STRONTIUM, DISS .86 .002 TITAHIUH DIS(HG/L AS TI) VANADIUH, DISS(HG/L AS V) ZINC, DISS (HG/L AS ZN) ZIRCONIUM DIS(HG/L AS ZR < .001 .004 CHROHIUH, DISS (MG/L-CR) ,003 COPPERIDISS (HG/L AS CU) LITHIUM, DISS (HG/L AS LI) .012 .73 .028 <.003 4,02 MOLYBDENUM, DISS (MG/L-MO)

REMARKS: FILTER LIGHT BROWN*WATER CLOUDY GEORGE KAVULLA*SAND COULEE, HT

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEG/L MILLIEQUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

OTHER AVAILABLE DATA Y SS W.C. OW PU AT OTHER

OTHER FILE NUMBERS:

PROJECT:

COST:

PROJECT: COST:
LAST EDIT DATE: 30-JUL-82 RY: TP *RCS
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT MED/L (FOR PIPER PLOT)
CA MG NA N CL 804 HC03 C03
56.1 37.0 6.0 0.8 2.0 49.8 47.5 0.0

## WAFER QUALITY ANALYSIS LAE NO. 8200498

```
STATE HONTANA

LATITUDE | ONGITUDE 47D24'52'N 111D09'28'W SITE | OCATION 19N 4F 12 BABA

UTH COORDINATES 7 N E MENG SITE

TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1 STATION UD 4/2452111092001

COOLOGIC SOURCE 220JKSC* * SAMPLE SOURCE WILL

100 COOLOGIC SOURCE WILL

                GEOLOGIC SOURCE
DRAINAGE BASIN
                                                                     220JKSC*
                                                                                                                                 * SAMPLE SOURCE
LAND SURFACE ALTITUDE
SUSTAINED YIELD
YIELD HEAS HETHOD
TOTAL DEPTH OF WELL
ABOVE(-) OR BELOW GS
CASING DIAMPIER
CASING TYPE
COMPLETION TYPE
                                                                                                                                                                                                          3430. FT 10
7.8 GFM
BUCKET/STOFWATCH
            DRAINAGE HASIN DE AGENCY E SAMPLER HRMG*WJR ROTTLE NUMBER EVLYMAN DATE SAMPLED 21-JUN-82 TIME SAMPLED 09:15 HOURS
                                                                                                                                                                                                          131, FT (F)
                                                                                                                                                                                                                                      FF (6)
                LAR F ANALYST
DATE ANALYZED
SAMPLE HANDLING
                                                                                                                                                                                                                        MIL
                                                                      14- JUL -82
                                                                                                                                                                                                           STIFL
                                                                                                                                                                                                                 *
                   HETHOR SAMPLED
                                                                   PUMPED
                                                                                                                                     PERFORATION INTERVAL
                                  WATER USE DOMESTIC
               SAMPLING SITE LYMAN, F*1ST HOUSE ACROSS ROAD FROM TRACY GEOLOGIC SOURCE JURASSIC UNDIFFERENTIATED
                                                                                                                                                                                                             MG/1
507.
                                                                        MG/L
                                                                                                       HEQ/I
                                                                                                                                                                                                                                       HER/L
                                                                                                       17.86 RICARRONATE
2.46 CARBONATE
                                                                                                                                                                          (11003)
             CALCIUN
                                              (CA)
                                                                         354.
                                                                                                                                                                                                                                             8.31
                                                                                                                                                                                                             18.9
                                                                         115.
27.7
5.5
             MAGNESIUM (MG)
                                                                                                                                                                               (003)
                                                                                                                                                                                                                                           0.53
                                                                                                             1.20 CHLORIDE
                                                                                                                                                                                   (CL)
             SONTUH
                                              (NA)
                                                                                                              0.14
                                                                                                                              SULFATE
                                                                                                                                                                                 (S84)
             POTASSIUM
                                                  (K)
                                                                                                             0.00 HITRATE
                                              (EE)
                                                                                                                                                                              (AS N)
              IRON
                                                                                                                                                                                      (F)
                                                                                                                                                                                                                      .18
             MANGANESE
                                                                                                             0.00 FLUORIDE
                                                                                                                                                                                                                                              0.01
                                             (RR)
                                                                                   .004
              SILICA (SIO2)
                                                                                                                              PHOSPHATE TOT (AS P)
                                                                                                                                                        TOTAL ANIONS
                   TOTAL CATIONS
                                                                                                                                                                                                                                            28.62
                                                                                                          28.47
                   STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                                                                                                                                      0,22
                                                                                                                                                                      (SIGHA)
                                                                                                    7.54
                                                                                                                                           TOTAL HARDNESS AS CACO3 1357.20
                                                     LABORATORY PH
      FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS
                                                                                                                                     TOTAL ALKALINITY AS CACO3
                                                                                                                                                                                                                                 415.83
                                                                                                                                           SODIUM ABSORPTION RATIO
RYZNAR STABILITY INDEX
                                                                                                      1737.03
                                                                                                                                                                                                                                  0.33
                SUM OF DISS. CONSTITUENT
                                                                                                                                                                                                                                        5.13
   LAB SPEC.COND. (HICROHHOS/CH)
                                                                                                    2172.
                                                                                                                                     LANGLIER SATURATION INDEX
                       PARAMETER
                                                                                                VALUE.
                                                                                                                                                         PARAMETER
                                                                                                                                                                                                                                 VALUE
                                                                                                                                PARAMETER
CNDUCTVY, FIFLD HIGROTHOS
ALKALINITY, FID (AS CACO3)
NICKEL, DISS (MG/L AS NI)
LEAD, DISS (MG/L AS FD)
STRONTIUM, DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS V)
ZING, DISS (MG/L AS ZN)
ZIRCONIUM DISS (MG/L AS ZR)
                                                                                               72. F
7.15
.26
                                                                                                                                                                                                                              2240.
TEMPERATURE, AIR (C)
FIELD PH
                                                                                                                                                                                                                                     .03
ALUMINUM, DISS (HG/L-AL)
STEVER, DISS (HG/L AS AG)
BORON , DISS (HG/L AS B)
CADHIUM, DISS (HG/L AS CD)
                                                                                                       .047
                                                                                                      .07
                                                                                                                                                                                                                                     1.08
                                                                                                       .015
                                                                                                                                                                                                                                     .039
CHROMIUM, DISS (MGZI-CR)
COPPER,DISS (MGZL AS CU)
LITHIUM,DISS(MGZL AS LI)
                                                                                                                                                                                                                                        .048
                                                                                                       .031
                                                                                                       .074
                                                                                                                                                                                                                                       .065
                                                                                                      .057
```

REMARKS: FILTER CLEAN*WATER CLEAR EVELYN LYHAN*SAND COULEE, MT

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MER/L = HILLIEQUIVELENTS FER LITER, ET = FEET, HT = HETERS. (H) = HEASURED. (F) = ESTIMATED. (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

> QW WA U I OM PW AT GIRER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

HOLYBDENUH, DISS(HG/L-HO)

PROJECT: COST: LAST CRIT RATE: 05-JAN-83 RY: PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: Tr * TP THAY BE

> PERCENT MEDIL (FOR PIPER PLOT) CI \$04 HC03 C03 CA HG KA 62.0 33.2 4.2 1.7 68.8 27.3 0.0

MONTANA BUREAU OF MINES AND GEOLOGY BUTTE, HONTANA 59701 (406)496-4101 WATER QUALITY ANALYSIS LAB NO. 8200499 STATE LATITUDE - LONGITUDE MONTANA COUNTY CASCADE 47023'46'N 111D09'09'W SITE LOCATION 19N 5E 18*CEDD UTH COORDINATES HBMG SITE STATION ID SOUTHEAST GREAT FALLS 7 1 330HDSN# # # TOPOGRAPHIC MAP 472346111090901 GEOLOGIC SOURCE DRAINAGE BASIN GENCY + SAMPLER BOTTLE NUMBER SAMPLE SOURCE WELL LAND SURFACE ALTITUDE SUSTAINED YIELD 3455. FT < 10 11.2 GPM BUCKET/STOPWATCH EE AGENCY MBHG*HRM YJELD HEAS HETHOD NET DATE SAMPLED TIME SAMPLED SWL ABOVE(-) OR BELOW GS 175. FT (R) 29.76 FT (H) 8 IN (H) : HOURS LAR & ANALYST DATE ANALYZED SAMPLE HANDLING MRMG*FNA 16-JUL 82 CASING DIAMETER CASING TYPE COMPLETION TYPE STEEL # METHOD SAMPLED PUMPED PERFORATION INTERVAL WATER USE DOMESTIC AND STOCK SAMPLING SITE TERRY NET*.75 HI NW OF CENTERVILLE GEOLOGIC SOURCE MADISON GROUP OR LIMESTONE HG/I. HER/L MG/I. HER/I 3.27 BICARBONATE 1.94 CARBONATE 65.5 (HC03) CALCIUM (CA) 271.3 4.45 23.6 (003) MAGNESIUM (MG) . 0 3.1 SODIUM (NA) 7.1 0.31 CHLORIDE (CL) 0.09 SULFATE 3.1 0.00 (504) POTASSIUM 1.37 (K) 65.7 .018 (AS N) 5.69 IRON (FE) 0.00 NITRATE 0.41 .50 MANGANESE (HN) .002 0.00 FLUORIDE 0.03 SILICA (SIG2) PHOSPHATE TOT (AS P) TOTAL CATIONS TOTAL ANIONS 5.60 6.33 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGHA) 3 . 13 1 7.68 TOTAL HARDNESS AS CACOS
12.5 C TOTAL ALKALINITY AS CACOS
323.66 SODIUM AUSORPTION RATIO
461.31 RYZNAR STABILITY INDEX 260.69 LABORATORY PH 222.51 0.19 6.99 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT LAB SPEC.COND. (HTCROHHOS/CH) 0.34

PARAMETER VALUE PARAMETER VALUE 597. 232. 85. F 7.12 CHDUCTVY, FIELD HICROPHOS ALKALINITY, FLD (AS CACO3) TEMPERATURE, AIR (C) FIELD PH .04 .02 ALUMINUH, DISS (HG/L-AL) NICKEL DISS (HG/L AS NI) SILVER, DISS (MG/L AS AG) BORON , DISS (MG/L AS B) CADHIUH, DISS (MG/L AS CD) <.024 LEAD, DISS (MG/L AS PB) STRONTIUM, DISS (MG/L-SR) .05 .34 ,007 TITANIUH BIS(HG/L AS TI) <.001 CHROHIUH, MISS (HGZL-CR)
COPPER,DISS (HGZL AS CU)
LITHIUH,DISS(HGZL AS LI) VANADIUH, DISS (HG/L AS V) .015 .015 ·028 ZINC/BISS (HG/L AS ZN) ZIRCONIUH DIS(HG/L AS ZR .15 MOLYBDENUH + DISS(HG/L-HO) .02

REMARKS: WATER CLEAR*SHELL AND TASTE OK*SOLID BROWN SPOTS ON FILTER SILT OWNERS ADDRESS BOX 95 STAR RT STOCKETT LAB: FU CA 76.6, MG 27.9 GIVES 6.51 MEQ CATIONS FOR --.84 SIGMA

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEG/L MILLIEQUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED. (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

QW NA S2 WI ON PW AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 30-JUL-82 DY: TP *RCS
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT MEQ/L (FOR PIPER PLOT)
CA MG NA K CI SO4 HC03 CO3
58.4 34.7 5.5 1.4 1.5 23.7 75.3 0.0

## WATER QUALITY ANALYSIS

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STATE MONTANA
LATITUDE LONGITUDE 47024/4
                                                                                    COUNTY CASCADE
                                47D24'48'N 111D05'46'W SITE LOCATION 15N 4F 12 DEAA
       UIN COORDINATES
                                                                               HANG SITE
                                                            NIS 7 1 STATION IN 472448111094601
* SAMPLE SOURCE W.L.
LAND SURFACE ALTITUDE 3440. FT 10
SUSTAINED YIELD GEM
        TOPOGRAPHIC HAP SOUTHEAST GREAT FALLS 7 1
        GEOLOGIC SOURCE
DRAINAGE BASIN
                                 330HDSN#
                                                        *
                                 B.E.
                                                                                                           FT 10
      AGENCY + SAMPLER
BOTTLE NUMBER
DATE SAMPLED
                                 ARHG*UJR
                                                              YIELD MEAS HETHOD BUCKLESTOPWATCH
TOTAL BEPTH OF WELL 158. (1 (1)
ABOVE() OR BELOW GS 101.36 FT (H)
CASING DIAMETER 6.5 IN (R)
CASING TYPE STEEL
GOMPLETION TYPE 01*
                                KAJALA
20 JUN 82
15:15 HOURS
       TIME SAMPLED
LAB + ANALYST
DATE ANALYZED
SAMPLE HANDLING
                                                        SWL
                                 HBHG*FNA
                                 14-JUL - 82
         METHOD SAMPLED WATER USE
                                 PUMPED
                                                              PERFORATION INTERVAL
                                DOMESTIC
       SAMELING SITE FAST ACROSS HIWAY TRACY*3RD HOUSE ON RIGHT GEOLOGIC SOURCE MARISON GROUP OR LINESTONE
                                                                                                 MG /1
233.7
                                                                                                           nF (2.21
                                                MER/I
                                                   3.78 DICARRONATE
                                   75.8
26.5
      CALCIUN
                     (CA)
                                                                                 (RC03)
                                                                                                              3.83
      MAGNESIUM (HG)
                                                                                 (0.03)
                                                                                                    7.2
                                    11.8
                                                   0.51
                                                                                                                0.26
                     (NA)
      SOBIUM
                                                           CHUORIDE
                                                                                    (CL)
                                                                                   (504)
      POTASSIUM
                                     2.5
                                                           SULFATE
                                                                                                 133.
                                                   0.06
                                     <.002
                                                           NITRATE
                                                                                                     .118
                     (FE)
                                                                                 (AS N)
      IRON
      MANGANESE
                     (NN)
                                      .005
                                                   0.00 FLUORIDE
                                                                                                      .54
                                                                                                                0.03
                                                                                      (F)
      SILICA (SIGE)
                                                           PROSPRATE TOT (AS F)
                                    11.8
                                                                                                                6.95
         TOTAL CATIONS
                                                   6.54
                                                                       TOTAL ANTONS
         STANDARD DEVIATION OF ANION-CATION BALANCE (SIGNA) 2:01
                                                              TOTAL HARDNESS AS CACOS
TOTAL ALKALINITY AS CACOS
                                                                                                          298.35
                         LABORATORY FH
                                                    7.58
                                                                                                          171.67
         FIELD WATER TEMPERATURE
                                                              SODIUM ADSORPTION RATIO
RYZNAR STABLLITY INDEX
LANGLIER SATURATION INDEX
                                                                                                          7.10
  CALCULATED DISSOLVED SOLIDS
SUM OF DISS. CONSTITUENT
                                                  387.15
                                               505.73
 LAB SPEC. COND. (HICROHHOS/CH)
                                             VALUE
          PARAHETER
                                                                       PARAMETER
                                                                                                          VALUE
                                                            CHRUCTVY, FILLD HICEDHOS
ALKALINITY, FLD (AS CACO3)
NICKEL, DISS (MG/L AS NI)
LEAD, DISS (MG/L AS PRI
STRONFIUM, DISS (MG/L AS FRI
                                             85. F
7.35
TEMPERATURE, AIR (C)
                                                                                                          640.
DIELD BH
                                                                                                         200.
ALUMTNUH, DISS (MG/L-AL)
SILVER,DISS (MG/L AS AG)
BORDN ,DISS (MG/L AS E)
CADMIUM,DISS(MG/L AS CD)
                                              .00
                                                                                                         .01
                                               .014
                                                                                                             .73
                                                             TITANJUH BIS(HG/L AS TI)
                                               .006
                                                                                                             .00-3
                                                            VANADIUH, DISS (HGZL AS ()
ZINC, DISS (HGZL AS ZN)
ZIRCONIUH DIS (HGZL AS ZR
CHRONIUM, DISS (NG/L AS CU)
COPPER, DISS (NG/L AS CU)
LITHIUM, DISS (NG/L AS LI)
                                                .010
                                                                                                             .016
                                                .032
MOLYBREHUH, DISS(HG/L-HO)
                                                .02
REHARKS: FILTER RUSTY BROWN*WATER CLOUDY RICHARD KUJALA*BOX 53*SAND COULEE
      LAB: FU CA 80.4, MG 28.4, NA 12.7 BIVES 6.96 MER CATIONS FOR .07 SIGMA
EXPLANATION: MG/L = MILLIGRANS PER LITER, UG/L = MICROGRANS PER LITER, HER/L
MILLIEQUIVELENTS PER LITER. FT = FEFT, Mf = MFTERS. (M) = MFASURED, (E) = CSTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE, TOT = TOTAL.
                                   UW
                                          MA
                                                S2
                                                     W T
                                                            กม
                                                                   F:13
                                                                       AI
                                                                                      OTHER
OTHER AVAILABLE DATA
                                           Υ
OTHER FILE NUMBERS:
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PROJECT: COST: LAST EDIT DATE: 30-JUL-82 FRUGRAM: F1730F V2 (11/3/81) TP *RCS 27 MAY 83 RY: PROCESSING PROGRAM: FRINTED:

PERCENT HERZI (FOR PIPER PLOT) S04 HC03 003 EL 7.8 57.8 33.3 3.8 40.4 55.8 0.0

### WATER QUALITY ANALYSIS LAB NO. 8200501

(SIGHA)

1,01

COUNTY CASCADE 47D26'22'N 111D10'29'W LATITUDE - LONGITUDE SITE LOCATION 20N SE 31*CDAA STATION IN 472622111102901 TOPOGRAPHIC HAP SOUTHEAST GREAT FALLS 7 1 DEGLOGIC SOURCE * SAMPLE SOURCE LAND SURFACE ALTITUDE UELL 330HDSN* * F: F: 3400. FI 10 AGENCY & SAMPLER BOTTLE NUMBER MRHG*HRH SUSTAINED YIELD 5,1 GEH SUSTAIRED TIELD
YIELD HEAS HETHOD
TOTAL DEPTH OF WELL
SWL ABOVE(-) OR BELOW 6S
CASING DIAHETER
CASING TYPE
COMPLETION TYPE BUCKET/STOPWATCH 125. FT (R) 65.45 FT (H) MOSMHOL DATE SAMPLED TIME SAMPLED 18-300-82 14:05 HOURS LAR + ANALYST DATE ANALYZED SAMPLE HANDLING HBHG*FNA (H) HI STEEL 16-1111-82 * METHOD SAMPLED PUMPED PERFORATION INTERVAL DOMESTIC AND STOCK WATER USE

SAMPLING SITE GENE JOHNSON RANCH 1.75 HI NE OF TRACY GEOLOGIC SOURCE HADISON GROUP OR LIMESTONE

CALCIUM (CA) HAGNESTUH (HG) SODIUM (HA) POTASSIUM (K) IRON (FE) MANGANESE (MN) SILICA (SIO2)	MG/L 146. 83.3 107. 3.3 .002 .002	6.85 4.65 0.08 0,00	BICARBONATE CARBONATE CHLORIDE SULFATE NITRATE FLUORIDE CHOSPHATE TOT	(HC03) (C03) (CL) (S04) (AS N) (E) (AS P)	#G/H 421. .0 13.9 564. 2.96 .37	MER/L 6.90 0.39 11.74 0.21 0.02
TOTAL CATIONS		18.88	TOTAL	ANIONS		19.27

707.42 LABORATORY PH 7.47 TOTAL HARDNESS AS CACO3 9.0 C TOTAL ALKALINITY AS CACO3
1147.52 SOUTH ADSORPTION RATIO
1361.13 RYZNAR STABILITY INDEX CALCULATED DISSOLVED SOLIDS 345.29 1.75

SUH OF DISS. CONSTITUENT 6.12 LAB SPEC.COND. (HICROHHOS/CH) 1585. LANGLIER SATURATION INDEX 0.67

PARAMETER	VALUE	PARABETER	VALUE
TEMPERATURE, AIR (C)	77. F	CNDUCTVY, FIELD HICROPHOS	1698.
FISUD PH	7.08	ALKALINITY, FLD(AS CACO3)	324.
ALUMINUH, DISS (MG/L-AL)	.06	NICKEL, DISS (MG/L AS NI)	<.01
SILVER, DISS (MG/L AS AG)	,011	LEAD, DISS (HG/L AS PB)	.05
BORON (DISS (HG/L AS R)	.23	STRONTIUM,DISS (HG/L-SR)	1.01
CADMIUM,DISS(MG/L AS CD)	.002	TITANIUH DIS(HG/L AS TI)	.007
CHROMIUM, DISS (MG/L-CR)	.008	VANADIUH, DISS(HGZL AS V)	.011
COPPERIDISS (MG/L AS CU)	.021	ZINC,DISS (HG/L AS ZN)	.013
LITHIUH, DISS(MG/L AS LI)	.067	ZIRCONIUH DISCHGZL AS ZR	.018
MOLYBRENUH, DISS(HG/L-HO)	.02		

REMARKS: NATER CLEAR*TASTE AND SHELL OK*FILTER CLEAR OWNERS ADDRESS STAR RT SAND COULEE

STANDARD DEVIATION OF ANION-CATION RALANCE

EXPLANATION: MG/I = MILLIGRAMS PER LITER, MG/I = MICROGRAMS PER LITER, MG/I MILLIEQUIVELENTS PER LITER. FT = FEET, MT = MSTERS. (H) = MEASURER, (E) = MSTIMATED, (R) = MSTIMATED

WD IN กน WA 5.2 PH AT BREE

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: LAST SHIT DATE: PROCESSING PROGRAM: TP *TF 05-JAN-83 RY: 27-MAY-83 F1730F V2 (11/3/81) PRINTED:

> DERCENT HERZL (FOR PIPER PLOT) CL S04 HC03 2.1 61.7 36.2 K CA MG NA 38.6 36.3 24.7 0.4 0.0

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STATE MONTANA LOURTY CALLADE AFER LATITUDE LOURTY CALLADE AFER LATITUDE LOURTY CALLADE AFER
                                                                        HAND SITE
STATION IN 4/18/9/1/1/19/0:
* SAME SOURCE WALL
LAND SURFACE ALTITUDE 35/10. 11 1
         UTH COORDINATES
                                       STOCKETT 7 1/
2/0/RSC*
         TOPOGRAPHIC MAP STO
GEOLOGIC SOURCE 220
DRAINAGE BASIN BE
       AGENCY + SAMPLER MRMG*HRM
BOTTLE NUMBER RSINGLE
BATE SAMPLED 21-JUN-8:
        DATE SAMPLED 21-JUN-82
TIME SAMPLED 14:39 HOURS
LAR + ANALYST MRMG*FNA
DATE ANALYZED 16-JUL-82
SAMPLE HANNEING
METHOR SAMPLED PUMPER
WATER USC
                                                                                    SUSTAIN: B YITLD
                                                                                                                         11 117
                                                                          YIELD MEAS METHOD BUCKETSTORWALCH

FOTAL REPTH OF WELL 55. FT ()

ABOVE() OR BELOW GS 25. FT (F

CASING DIAMFTER (IN (F)

CASING TYPE PLASITE

COMPLETION TYPE PLASITE
                                                                   SWL
                                                                           PERFORATION INTERVAL
         SAMPLING SITE RALPH SINGLE 3.25 HI SW OF STOCKETT GEOLOGIC SOURCE JURASSIC UNDIFFERENTIATED
                                                                                                                    273.3
                                         MG/I
                                                          HE R/I
                                                                                                                                   HEG I
                                          57.3
                                                          2.86 RICARRONATE
2.17 CARBONATE
0.32 CHIORIDE
       CALCIUM
                          (CA)
                                                                                                 (HC03)
                                                                                                                                    4.43
                                           26.4
                                                                                                                      34.2
       MAGNESTUM (MG)
                                                                                                  (003)
                                           7.3
       SOPIUM
                          (NA)
                                                                                                     (CL)
                                                                                                                                      0.07
                                                             0.08 SULFATE
                          (1,)
       POTASSIUM
                                                                                                   (504)
                                                                                                                                      0.71
                                             .002
                                                                                                                       4.18
       IRON
                         (FE)
                                                                                                  (AS N)
       MANGANESE
                                              .002
                         (MN)
                                                             0.00 FLUDRIDE
                                                                                                       (F)
                                                                                                                                       0.05
       SILICA (SIG2)
                                                                       PHOSPHATE TOT (AS P)
           TOTAL CATIONS
                                                             5.43
                                                                                     TOTAL ANIBNS
                                                                                                                                       5.60
           STANDARD DEVIATION OF ANION CATION DALANCE (SIGHA)
                                                                                                               0 97
                                                           7.20 TOTAL HARDNESS AS LACOS
9.2 C TOTAL ALNALINTLY AS CACOS
277.20 SODIUM ADSORPTION RATIO
415.87 RYTHAR STABILITY INDEX
509.4 LANGLIER SATURATION THREX
                                                                                                                                251. 24
                              LABORATORY FH
                                                                                                                               724.15
           FIELD WATER TEMPERATURE
 CALCULATEN DISSOLVED SOLIDS
SUM OF DISSOLVED SOLIDS
LAD SPEC.COND. (MICROMHOS/CM)
                                                        415.87
                                                                                                                                 .0.10
             PARAMETER
                                                      VALUE
                                                                                     PARAMETER
                                                                                                                               VALUE
                                                      VALUE

81. F
CNDUCTVY,FIELD HICROPHOS
6.45
4LKALINITY,FLD(AS CACO3)
4.03
NICKEL,DISS (HG/L AS PR)
4.002
LEAD,DISS (HG/L AS PR)
4.02
STRONTIUH,DISS (HG/L SE)
TERRERATURE, AIR (C)
                                                                                                                                528.
                                                                                                                              30.
FIELD PH
ALUNINUM, DISS (HG/L-AL)
SILVER, DISS (HG/L AS AG)
DORON, DISS (HG/L AS B)
                                                                                                                               .02
                                                                                                                                 . . 7
                                                                                                                                   .10
                                                                        TITANTUM FISCHGZE AS TELL VANABTUM-FISSCHGZE AS TELL ZINC-FISS (HGZE AS ZN) ZIRCONTUM FISCHGZE AS ZR
                                                        €,000
CADMIUM, DISS (MG/L AS CD)
                                                                                                                                  .004
CURONIUM, DICS (NG/L-CR)
COPPER, DISS (NG/L AS CU)
LITHIUM, DISS (NG/L AS LI)
                                                         .002
                                                                                                                                 .001
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REMARKS: WATER CLEAR*TASTE % SHELL OK*CLEAN FILTER
OWNERS ADDRESS STAR RT STOCKETT
LAH: FU CA 59.3, MG 27.7 GIVES 5.64 MEG CATIONS FOR ... 3 SIGNA

.020 .007

< .02

EXPLANATION: MG/L = MILLIGRAMS PER LITCR+ UG/L = MICROGRAMS PER LITCR+ MFG/L MILLIFOUTVELENTS PER LITER. FT = FFFT, MT = METERS. (M) = MEASURED, (E) = CSTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE, LOT = TOTAL.

> QW IJA S 2 WI ถน PW A? OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

MOLYROENUM, DISS(HG/L-HO)

COST: PROJECT: LAST ERIT DATE: 05-JAN-03 BY: PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: fP * FP 27 MAY-83

> PERCENT MER/L (FOR PIPER PLOT) CA MG NA L CL S04 HC03 C03 52.6 40.0 5.8 1.6 1.4 13.5 85.1 0.0

MONTANA BURGAU OF MINES AND GEULUGY BULLE-MONTANA 59201 (406)496 4101

WATER QUALITY ANALYSIS LAB NO. 8200503

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STATE MONTANA
                                                                                          COUNTY CASCADE
                                                                             SITE LOCATION 18N 4F 11 AAAC HRHG SITE STATION ID 4/1959111104101 SAMPLE SOURCE WELL TO CONTROL OF T < 10
                                  47019'59'N 111010'41'N Z N E STOCKETT Z 1/2'
   LATITUDE - LONGITUDE
        UTH COORDINATES
        FOROGRAPHIC MAP
        GEOLOGIC SOURCE
BRAINAGE BASIN
                                   217KOTN*221HRSN*
                                                                LAND SURFACE
                        BASIN
                                   F: 3:
                                                                    YIELD HEAS HETHOD BUCKET/STOPWATCH
TOTAL DEPTH OF WELL 131. ET (B)
      AGENCY + SAMPLER
BOTTLE NUMBER
                                   HINHG*HRM
             CY & SAMPLER DANGER DESCRIPTION OF THE SAMPLED 21-JUN-82
TIME SAMPLED 1800 HOURS
                                                                                                       131. FT (R)
17.70 FT (H)
                                                           SWL ABOVE (-) OR BELOW GS
        LAR + ANALYST
DATE ANALYZER
SAMPLE HANDLING
                                                                          CASING DIAMETER 6
CASING TYPE SIE
COMPLETION TYPE 03*
                                  HBMG*ENA
                                                                                                         6 311 (H)
                                  16- JUL-82
         METHOD SAMPLED PUMPED
                                                                  PERFORATION INTERVAL
                                  DOMESTIC AND STOCK
                  WATER USE
        SAMPLING SITE DONALD YUREK RANCH 1.75 HI SW OF STOCKETT GEOLOGIC SOURCE KOOTENAL FORMATION
                                    MOZI.
                                                   REQ/L
                                                                                                       MG/1
                                                                                                                    MER/L
                                                      3.38
2.99
0.92
                                                                                      (E003)
      CALCIUH
                      (CA)
                                     67.8
                                                              BICARBONATE
                                                                                                       371.9
                                                                                                                        6.10
                                                                                                         2.8
                                      36.4
                                                               CARBONATE
      MAGNESIUM (MG)
                                      21.2
      SODJUH
                       (NA)
                                                               CHEORIDE.
                                                                                          (CL)
                                                                                                                        0.08
                                                               SULFATE
MITRATE
      POTASSIUM
                                                       0.17
                                                                                         (SU4)
                                                                                                                        0.27
                       (K)
                                                                                                         36.8
                                        ..002
                                                                                                          5.47
                                                                                       (AS N)
      TRON
      HANGANESE (HN)
                                                       0.00 FLUGRIDE
                                                                                           (F)
                                                                                                            .57
                                         .050
                                                                                                                        0.05
      SILICA (SIG2)
                                                               PHOSPHATE TOT (AS P)
         TOTAL CATIONS
                                                       7.47
                                                                            CHOINA HATORS
                                                                                                                        7.38
                                                    7.37 TOTAL HARDNESS AS CACO3
10.1 C TOTAL ALKALINITY AS CACO3
368.69 SODIUM ADSORPTION RATIO
557.39 RYZNAR STABILITY
657.1 LANGLIES
         STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                          -0,41
                                                                                                                 319.12
                          LABORATORY PH
         FIELD WATER TEMPERATURE
                                                                                                                 305.02
  CALCULATED DISSOLVED SOLIDS
SUM OF DISS. CONSTITUENT
                                                                                                                  0.52
                                                                                                                    7.00
 LAB SPEC.COND. (MICROMHOS/CH)
                                                                                                                    0.15
           PARAMETER
                                                VALUE
                                                                            PARAMETER
                                                                                                                 VALUE
                                                                PARAMETER
CNDUCTVY/FIELD MICROMHOS
ALKALINITY/FLD(AS CACO3)
NICKEL/DISS (MG/L AS NI)
LSAB/DISS (MG/L AS FB)
STRONTIUM/DISS (MG/L AS TI)
TITANIUM DIS(MG/L AS TI)
VANADIUM/DISS(MG/L AS ZN)
ZIRCONIUM DIS(MG/L AS ZR)
                                                6,63 F
TEMPERATURE, AIR (C)
                                               84.
                                                                                                                 677.
FIELD PH
                                                                                                                324.
                                                 <.03
ALUHINUM, DISS (HG/L-AL)
                                                                                                                  < .01
SILVER, DISS (HG/L AS AG)
DORON DISS (HG/L AS B)
CADHIUM, DISS (HG/L AS CD)
                                                 <.002
                                                                                                                   .04
                                                 .25°
                                                                                                                   <.001
CHROHIUM, DISS (HG/L-CR)
COPPER, DISS (HG/L AS CU)
LITHIUM, DISS (HG/L AS LI)
                                                 <.002
<.002
.047
                                                                                                                   <.001
                                                                                                                   5.00
                                                                                                                   <.003
MOLYBRENUM, DISS(MGZU-HO)
                                                  <.02
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REMARKS: WATER CLOUDY *TASTE AND SHELL OK*LIGHT BROWN SILTY FILTER OWNERS ADDRESS STOCKETT*RUNNING WATER CLEAR FOR 7 MIN*FLOW 16.4 GPH* WATER BECAME VERY CLOUDY AND FLOW 7.2 GPM FOR 8 MIN*NATER CLEARED

EXPLANATION: MG/L = MILLIGRAMS PER LITER. UG/L = MICROGRAMS PER LITER. HEQ/L: MILLIEQUIVELENTS PER LITER. ET = FEET, HT = HETERS. (H) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

A Y ON PN AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT:

LAST EDIT DATE: 30-JUL-82

PROCESSING PROGRAM: F1730P V2 (11/3/81)

PRINTED: 27-MAY-83

PERCENT MEQ/L (FOR PIPER PLOT)
CA MG NA K CL 904 HC03 C03
45.3 40.1 12.4 2.2 1.1 11.0 87.8 0.0

WATER QUALITY ANALYSIS

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COUNTY CASCADE
                             AUNTANA
  LATITUDE - LONGITUDE 47D24'24'N 111D09'38'W SITE LOCATION 12H 4E 13 AAFR
                                                                   HRHG SITE
STATION ID 4/2424111093801
SAMPLE SOURCE UPLE
       UTH COORDINATES
TOPOGRAPHIC MAP
                                   N
                              SOUTHEAST GREAT FALLS 7 1
       GEOLOGIC SOURCE
DRAINAGE BASIN BB
                                       *
                                                   *
                                                              水
                                                        LAND SURFACE ALTITUDE
SUSTAINED YIELD
         BOTTLE NUMBER
                                                                                         3455.
                                                                                                   FT
     AGENCY
                              MRHG*WJR
                                                                                                   Gfth
                   NUMBER
                                                              YIELD HEAS HETHOD BUCKET/STOPWATCH
                              LYNCH
           DATE SAMPLED 18 JUN-82
TIME SAMPLED 09:30 HOURS
                                                   TOTAL DEPIH OF WELL
SWL ABOVE(-) OR BELOW GS
CASING DIAMETER
                                                                                         168. FT 1
                                                                                                  ST (E)
          LAB + ANALYST
                             HRMG*FNA
                                                                                          6 111
                                                                CASING TYPE STEEL
       DATE ANALYZED 14-JUL-82
SAMPLE HANDLING
METHOD SAMPLED PUMPED
                                                         PERFORATION INTERVAL
               WATER USE DOMESTIC
          CAMPLING SITE MIDDLE OF FIFLD & OFF TRACY-SAND COULEF RD
       GEOLOGIC SOURCE
                                                                                         KG/1
                                                                                                    HERZI.
                               MG/I.
                                            HER/I
                                                                                                       4,29
                   (CA)
                                87.8
                                                                           (HC03)
                                                                                         261.0
     CALCIUH
                                               4.38 BICARRONATE
                                               2.60
                                                                            (603)
                                                                                           7.2
                                 31.6
     MAGNESIUM (MG)
                                                      CARBONATE
                                                                             (CL)
                                                      CHLORIDE
                                                                                                       0.26
                                 13.1
     SODIUH
                    (NA)
                                                                                         148.
     POTASSIUM
                                 2.7
                                               0.07
                                                      SULFATE
                                                                            (SO4)
                                                                                                       3.08
                    (K)
                                                                                            . 44
                   (FE)
                                  <.002
                                                      NITRATE
                                                                           (AS N)
     IRON
                                                                                                       0.03
     MANGAHESE
                                                      FLUORIDE
                                                                                             .52
                   (HH)
                                    .001
                                               0.00
                                                                               (F)
                                                                                                       0 03
     SILICA (SID2)
                                 13.1
                                                      PHOSPHATE TOT (AS P)
        TOTAL CATIONS
                                                                                                       7.69
                                               7.62
                                                                  TOTAL ANIONS
        STANDARD DEVIATION OF ANION CATION BALANCE
                                                                         (SJGHA)
                                                                                            0.31
                                                                                                 349.30
                      LABORATORY PH
                                                7.45
                                                            TOTAL HARDNESS AS CACO3
                                                         TOTAL ALKALINITY AS CACO3
SODIUM AUSORPTION RATIO
RYZNAR STABILITY INDEX
LANGLIER SATURATION INDEX
 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT LAB SPEC.COND.(HICROMHOS/CM)
                                                                                                 214.50
                                                                                                  0.31
                                             435.33
                                              568.06
                                              675.1
                                                                                                  VALUE
                                          VALUE
                                                                  PARAMETER
                                                        FIELD PH
CNDUCTVY, FIELD MICROHHOS
                                          700.
                                                                                                   7.51
                                                       ALUMÎNUH, DISS (MG/L-AL)
SILVER,BISS (MG/L AS AG)
BORON ,DISS (MG/L AS D)
ALKALINITY, FLD (AS CACO3)
                                        216.
                                                                                                   .03
                                          < . 0.1
                                                                                                   T.002
NICKEL, DISS (HG/L AS NI)
LEAD, DISS (HG/L AS FD)
STRONTIUM, DISS (HG/L-SR)
                                           < . 04
                                                        CADHIUM, DISS(HG/L AS CD)
CHROHIUM, DISS (HG/L-CR)
                                           .89
                                                                                                   <.002
TITANIUH DIS(MG/L AS TI)
VANADIUH, DISS(HG/L AS V)
ZINC, DISS (HG/L AS ZN)
ZIRCONIUH DIS(HG/L AS ZR
                                                                                                   < .002
                                                       COPPER/DISS (HG/L AS CU)
LITHIUM, DISS (HG/L AS LI)
                                           < .001
                                                                                                   .007
                                                                                                   .022
                                          1.14
                                           < .003
                                                        MOLYBRENUH, RISS (MG/L-HO)
```

REMARKS: FILTER CLEAN*WATER CLEAR RENEE LYNCH*BOX 71*SAND COULEE*LOG UNKNOWN*DRILLED HARCH 1944

EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, <math>HFR/L HILLIERUIVELENTS PER LITER. FT = FFET, HT = HETERS. (H) = MEASURED, (F) = ESTIMATED, (R) = REPORTED, TR = TOTAL RECOVERABLE, TOT = TOTAL.

F. W AT OTHER UM WA \$2 WI ถม

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: PROCESSING PROGRAM: 30 - JUL - 82 BY: TF #805 F1730P V2 (11/3/81) 27-MAY-83 PRINTED:

> PERCENT MEQUL (FOR PIPER PLOT) HG NA K 7.5 0.7 CL SO4 HCO3 CA 0.03 7.5 3.4 40.4 56.2 57,5 34,1

MONTANA BUREAU OF MINES AND GEOLOGY EUTTE, MONTANA 59701 (406)496-4101

WATER QUALITY ANALYSIS LAB NO. 8200505

STATE MONTANA ITUDE 47D23/05'N 111D11/40'W COUNTY CASCADE LATITUDE - LONGITUDE SITE LOCATION 19N 04E 23*CRBA UTH COORDINATES N MRHG SITE SOUTHEAST GREAT FALLS 7 1 217KOTH*220JRSC* * TOPOGRAPHIC MAP DRAINAGE BASTE ENCY STATION ID 472305111114001 * SAMPLE SOURCE WELL LAND SURFACE ALTITUDE 377 SUSTAINED YIELD GEOLOGIC E E 3770 . AGENCY + SAMPLER BOTTLE NUMBER DATE SAMPLED TIME SAMPLED 4.7 GPM **HRHG*WJB** YIELD HEAS HETHOD TOTAL DEPTH OF WELL SWL ABOVE(-) OR BELOW GS CASING DIAHETER SWARTZR 22-JUN-82 18:30 HOURS BUCKET/STOPWATCH 248, FT 170, FT (R) FT (E) LAB + ANALYST DATE ANALYZED SAMPLE HANDLING METHOD SAMPLED HRHG*FNA 1.5 H STEEL 3H (R) CASING TYPE
COMPLETION TYPE
PERFORATION INTERVAL 16-301-82 01# PUMPED WATER USE DOMESTIC SAMPLING SITE SWARTZENBURGER, GERALD* GEULOGIC SOURCE KOOTENAI FURHATION HERZI. MG/1. KG/L HFR/L 46.5 CALCIUM (CA) 2.32 BICARBONATE (HC03) 516. 8.45 MAGNESIUM (HG) 78.8 6.48 CARBONATE (003) (). SODIUM 11.0 (NA) 0.48 CHLORIDE (CL) 3.8 0.11 23.7 0.49 POTASSIUM (K) 3.2 0.08 SULFATE (\$04) <.002 NITRATE IRON (FE) (AS N) MANGANESE (HN) FLUORIDE (F) <.001 0.07 PHOSPHATE TOT (AS P) SILICA (SIG2) 6.5 TOTAL CATIONS 9.36 TOTAL ANJONS 9.44 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGHA) 0.30 LABORATORY PH 440.45 7.70 TOTAL HARDNESS AS CACO3 FIELD WATER TEMPERATURE TOTAL ALKALINITY AS CACO3 423.21 CALCULATED DISSOLVED SOLIDS SUM OF DISS, CONSTITUENT 433.38 675.19 793.3 SODIUM ADSORPTION RATIO RYZNAR STABILLITY INDEX 0.23 LAB SPEC. COND. (HICROHHOS/CH) LANGLIER SATURATION INDEX 0.49 VALUE PARAMETER PARAMETER VALUE 72. F 7.17 TEMPERATURE, AIR (C) CNDUCTVY, FIELD HICROPHOS 796. ALKALINITY, FLD (AS CACO3) FIELD FW 433. ALUHINUM, DISS (MG/L-AL) SILVER,DISS (MG/L AS AD) DORDN ,DISS (MG/L AS E) 01 <.03 NICKEL,DISS (MG/L AS NI) LEAD,DISS (MG/L AS PB) <.002 STRONTIUM, DISS (MG/L-SR) .48 <.02 TITANIUM DIS(HG/L AS TI)
VANADIUM,DISS(HG/L AS V)
ZINC,DISS (HG/L AS ZN)
ZIRCONIUM DIS(HG/L AS ZR) CADMIUM, DISS(MG/L <.006 AS CD) .003 CHROMIUM, DISS (HG/L-CR) COPPER, DISS (HG/L AS CU) LITHIUM, DISS (HG/L AS LI) <.002 < .001 <.001 .33

REMARKS: FILTER COVERED WITH SILT * WATER CLOUDY GERALD SWARTZENBURGER * SAND COULEE MT

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MER/L: HILLIEQUIVELENTS PER LITER. ET = FEET, HT = METERS. (H) = MEASURED. (E) = ESTIMATED. (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

> 52 WI PU OTHER G U WA nu AT Y

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

HOLYBDENUM, DISS (MG/L-HO)

COST: PROJECT: LAST EDIT DATE: 05-JAN-83 BY: TP *TP PROCESSING PROGRAM: F1730F V2 (11/3/81) 27-HAY-83 PRINTEDI

.046

< .02

PERCENT HEQZL (FOR PIPER PLOT) K 0.9 CI S04 HC03 CA MG 0.03 AK 24,8 67.2 1.2 5.4 93.4 5.1 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8280505 Reads

<.003

BUTTE HONIANA 59701 (406)496 4101 WATER QUALITY ANAL 15/5 STATE 47023'32'N 111008'38'W MONTANA COUNTY CALCAME LATITUDE - LONG TTUDE UTM COORDINATES SILE LOCATION ISH OSE 18 DODS HRHG STIE UTM COORDINATES & N
TOPOGRAPHIC MAP SOUTHEAST GRE
GFOLOGIC SOURCE JJOMBSN*
DRAINAGE BASIN BE
AGENCY + SAMPLER MEMGEHRM
FOTILE NUMBER CENSECT
DATE SAMPLED 29-DEC-82
TIME SAMPLED 10:45 HOURS
LAB + ANALYST MEMGENA
DATE ANALYZED 19-JAN-83
SAMPLE HANDLING
METHOD SAMPLED PUMPED SOUTHEAST GREAT FALLS 7 1 330MBSN# # # STATION TO 477345111083801 SAMPLE SOUNCE WELL PRACE AUTITUDE 3475.0 FT LAND SURFACE SUSTAINED YIELD YTELD MEAS METHOD SWL ABOVE( ) OR BELOW GS 200. FF (R) PUE IN (M) CHI CASING DIAMETER CASING TYPE * PERFORATION INTERVAL MITHOD SAMPLED PUMPED WATER USE DOMESTIC SAMPLING SITE CENTERVILLE SENIOR CITIZENS CENTER GEOLOGIC SOURCE MADISON GROUP OR LIMESTONE MG/L MEGIL MG/L MERIL 12.03 BICARBONATE 105. 241. (HC03) 6.69 CALCIUM (CA) 0. (003) 135. CARBONATE HAGNESIUM (MG) 11.11 755. SODIUM 1.00 CHLORIDE (CL) 0.66 (NA) (804) (AS N) SULFATE 15.72 POTASSIUM 4 . 1 0.11 (K) 0.002 TRON MANGANESE 0.00 FLUORIDE (F) (MN) .004 0.03 SILICA (SIO2) 16.5 PHOSPHATE TOT (AS P) TOTAL CATIONS 24.24 TOTAL ANIONS 23.76 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA) -0.83 LABORATORY PH 3.52 1157.43 TOTAL HARDNESS AS CACOS FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT 6.8 C TOTAL ALKALINITY AS CACOZ 1411.41 SODIUM ADSORPTION RALLO 1616.90 RYZNAR STABILITY INDEX 332.17 1616.90 6.57 1701. LANGLIER SATURATION INDEX -0.03 LAB SPEC.CONIL (MICROMHOS/CM) PARAMETER VALUE PARAMETER VALUE F 20.5.70 CNDUCTUY, FIELD MICROMHOS ALKALINITY, FLD (AS CACO3) 1580. TEMPERATURE, AIR (C) FIELD PH ALUMINIM, DISS (MG/L-AL) SILVER, DISS (MG/L AS AG) DORON - DISS (MG/L AS B) CADMIUM, DISS (MG/L AS CD) 1.03 .01 NICKEL, DISS (MG/L AS NI) LEAD, DISS (MG/L < .002 AS PE) .82 STRONTIUM, DISS (MG/L-SR) .11 TITANIUM DIS(MG/L AS TI)
VANADIUM, DISS(MG/L AS V)
ZINC, DISS (MG/L AS ZN)
ZIRCONIUM DIS(MG/L AS ZR .002 CHROMIUM, DISS (MG/L-CR) COPPER, DISS (MG/L AS CU) LITHIUM, DISS (MG/L AS LI) .004 .004 .038 .034 1.003 .046 ARSENIC, DISS(UG/L AS AS) MOLYBRENUM, DISS(MG/L-MO) 1.02 REMARKS: WHITE FOAM COATS STEEL TAPE, DRIES TO HARD WHITE PPT., FILTER CLEAN EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MER/L 52 0.0 FW OTHER UW WA W T AT

MILLIERUTVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL. ESTIMATED: (R) = REPORTED.

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: AST EDIT DATE: 02=FEB-83 BY: TF *RCS PROCESSING PROGRAM: F1730F V2 (11/3/81) 27-MAY-83 PRINTED:

> PERCENT MED/L (FOR PIPER PLOT) CA MG NA LL S04 HC03 C03 h 49.6 45.8 4.1 0.4 2.7 68.3 28.8

MONTANA BUREAU OF MINES AND GEOLOGY BUTTE, MONTANA 59701 (406)496-4101

- WATER QUALITY ANALYSIS LAR NO. 8300002

STATE MONTANA COUNTY CASCADE LATITUDE-LONGITUDE 47024/52'N 111008/55'N SITE LOCATION 19N SE 7*RDDC MBMG SITE STATION ID UTH COORDINATES N TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1 STATION ID GEOLOGIC SOURCE 330HDSN* * * SAMPLE SOURCE 472452111085501 GEOLOGIC SOURCE 330 DRAINAGE BASIN BB AGENCY + SAMPLER MBN BOTTLE NUMBER GRE WELL LAND SURFACE ALTITUDE SUSTAINED YIELD 3455. FT < 10 **MRMG*HRM** BUTTLE NUMBER GHEAL-2

DATE SAMPLED 30-DEC-82

TIME SAMPLED 11:30 HOURS
LAB + ANALYST MEMG#FNA
DATE ANALYZED 19-JAN-83

SAMPLE HANDLING
HETHOD SAMPLED PUMPED
WATER USE STOCK

VIELD MEAS METHOD
SWL ABOVE(-) OR BELOW GS
CASING DIAMETER
CASING TYPE
COMPLETION TYPE
PERFORATION INTERVAL 220.0 (E) (H) 6 IN (M) TRON * SAMPLING SITE HEAL WELL-2 TRACY GEOLOGIC SOURCE MADISON GROUP OR LIMESTONE 233.0 MEQ/L MERZIL MG/L 97.3 89.4 CALCIUM (CA) 4.86 RICARBUNATE (RC03) 3.83 MAGNESIUM (MG) 7.35 CARRONATE (003) 0. 25.0 0.96 CHLORIDE SODIUM (NA) (CL) 13.8 0.39 0.21 SULFATE NITRATE (K) (FE) 428. 8.91 POTASSIUM 8.0 (504) <.002 IRON 1.83 (AS N) MANGANESE (MN) .003 .55 0.00 FLUURIDE (F) 0.03 SILICA (SIG2) 8.7 PHOSPHATE TOT (AS P) TOTAL CATIONS 13.37 TOTAL ANIONS 13.29 -0.27 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA) 7.56 TOTAL HARDNESS AS CACO3 7.3 C TOTAL ALKALINITY AS CACO3 284.76 SODIUM ADSORPTION RATIO LABORATORY PH TOTAL HARDNESS AS CACOS 610,93 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS 191.76 SOTIUM ADSORPTION RATIO RYZNAR STABILITY INDEX LANGLIER SATURATION INDEX 0.39 903.38 SUM OF DISS. CONSTITUENT SPEC.COND.(MICROMHOS/CH) CONSTITUENT 6.90 1115. PARAMETER VALUE PARAMETER VALUE PARAMETER
CNDUCTVY, FIELD MICROMHOS
ALKALINITY, FLD (AS CACO3)
NICKEL, DISS (MG/L AS NI)
LEAD, DISS (MG/L AS PE)
STRONTIUM, DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS TI)
ZINC, DISS (MG/L AS ZR
ARSENIC, DISS (UG/L AS AS) 30.0 F 6.80 TEMPERATURE, AIR (C) 1151. FIELD PH 205.00 ALUMINUM, DISS (MG/L-AL) <.01 SILVER, DISS (MG/L AS AG)
BORON , DISS (MG/L AS B)
CABMIUM, DISS (MG/L AS CD) <.002 <.04 < 1005 .86 .010 CHROMIUM, DISS (MG/L-CR) COPPER, DISS (MG/L-CR) LITHIUM, DISS (MG/L AS LI) HOLYBDENUM, DISS (MG/L-MO) <.002 .002 .008 .053 <.003

REHARKS: CLEAR

FILTER A LITTLE YELLOWISH, VERY FINE SILT ON FILTER AND SAND

EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, HG/L HILLIEGUIVELENTS PER LITER, FT = FEET, MT = HETERS, (H) = HEASURED, (E) = ESTIMATED, (R) = REPORTED, TR = TOTAL RECOVERABLE, TOT = TOTAL.

QW. WA 92 WI OW PW AT DIHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: LAST EDIT DATE: 02-FEB-83 PROCESSING PROGRAM: F1730P V2 (11/3/81) TP *BCS BY: PRINTED: 27-MAY-83

<.02

PERCENT MEQULE (FOR PIPER PLOT) NA K CL S04 HC03 7.2 J.5 3.0 67.7 27.2 CA MG 003 33.3 55.0

### WATER QUALITY ANALYSIS LAR NO. 8300003

```
STAFF MONTANA
                                                                                                COUNTY CASCADE
                                    47024'21'N 111008'16'W
                                                                                   SITE LOCATION 12N 04E 13 AAAD
   LATITUDE LONGITUDE
        UTH COORDINALES
                                                                     # SAMPLE GOURGE WELL
LAND SURFACE ALTIUDE 3440, FT 10
SUSTAINED YIELD
YIELD DEAS DETHUD
         IDEOGRAPHIC MAP
                                     SOUTHEAST GREAT FALLS 7 1
      TOPOGRAPHIC MAP SOUTHEAST GREAT GEOLOGIC SOURCE 330MDSN*

DRAINAGE BASIN RR
AGENCY + SAMPLER MRMG*HRM
DOTILE NUMBER MIKEKAV

DAIF SAMPLED 29-DEC 82

TIME SAMPLED 15:00 HOURS
LAR + ANALYST MRMG*FNA
DATE ANALYZED 19 JAN 83

SAMPLE HANDLING
METHOD SAMPLED PUMPED
WATER HSE DOMESTIC
                                                                #
                                                                      TOTAL DEPTH OF WELL AROVE(-) OR BELOW OS CASING DIAMETER
                                                                                                               170.0 FT (R)
                                                                                                               7 IN (R)
                                                                                CASING TYPE IRON COMPLETION TYPE 12#
                                                                       PERFORATION INTERVAL
                  WATER USE DOMESTIC
        SAMPLING SITE M NAVULA, STAR RT, SAND COULEE, N DE 7 SIDINS
GEOLOGIC SOURCE MADISON GROUP OR LIMESTONE
                                                                                                              M5/1
                                                                                                                          MEGZI
                                                       SEQ71
                                       MG/L
                                                          5.87
                        (GA)
                                       118.
                                                                   DICARDONALL
                                                                                            CHCO3D
                                                                                                              240.1
       CALCIUM
                                                                                                                0.
                                        36.0
                                                                                             (003)
       MAGNESTUM (MG)
                                                                   CARBONATI
                                                                                              (804)
                                                                                                              3.85
                                                                                                                               0.1750.77
                                        16.7
                                                                   CHLORIDE
SULFATE
       SOLIUM
                        (NA)
       POTASSIUM
                                          3.4
                                                          0.00 NITRATE
                                           .003
                         (FE)
                                                                                            CAS N)
       IRON
                                            .004
                                                          0.00 FLUORIDE (F)
PHOSPHATE TOT (AS F)
                                                                                                                  .32
                                                                                                                                0.02
       MANGANESE
                         (MN)
       SILICA (SID2)
                                        14.7
          TOTAL CATIONS
                                                          9.67
                                                                                 TOTAL ANTONS
                                                                                                                                9.64
          STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                        (SIGHA)
                                                                                                                   0.12
                                                            7.4
                                                                                                                        442.82
                            LABORATORY PH
                                                                          TOTAL HARDNESS AS CACOS
                                                        3.7 C IOTAL ALKALINITY AS CACO3
569.46 SORIUM ARSORPTION RATIO
691.28 RYZNAR STABILITY INDEX
829.3 LANGLIER SATURATION INDEX
                                                                                                                        176.72
  FIFE B WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS
                                                                                                                            0.87
        SUM OF DISS. CONSTITUENT
 LAB SPEC.COND. (MICROMHOS/CM)
                                                   VALUE
                                                                                                                         VALUE
            PARAMETER
                                                                                 PARAMETER
                                                                    PARAMITEN
CNBUCTVY, FIELD MICROMHOS
ALKALINITY FIELD MICROMHOS
NICKEL, DISS (MSZL AS NI)
LEAD, DISS (MSZL AS PB)
STEGNTIUM, DISS (MSZL AS TI)
VANABIUM, DISS (MSZL AS TI)
VANABIUM, DISS (MSZL AS V)
ZINC, DISS (MSZL AS ZN)
ZIRCONIUM BIS (MSZL AS ZR
ARSENIC, DISS (USZL AS AS)
                                                                                                                       278.
                                                   25. F
6.10
TEMPERATURE, AIR (C)
FIELD PH
                                                                                                                         .02
                                                    5.03
ALUMINUM, DISS (MG/L-AL)
SILVER DISS (MS/L AS AS)
BORON DISS (MG/L AS E)
                                                     :.000
                                                                                                                           ..04
                                                                                                                           .67
                                                      .10
CADMIUM, DISS(MS/L AS CD)
                                                      .003
                                                                                                                            .014
```

REMARKS: INITIAL TAP WATER RUSTY COLOR FOR 5 SEC, FILTER ALSO RUST COLORED

.002

<.02

.016

EXPLANATION: MSZL = MILLIGRAMS PER LITER, UGZL = MICROGRAMS PER LITER, MCGZL HILLTERDIVELENTS PER LITER. FT = FEET, HT = HETERS. (M) = HEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

> PW QV NA SR LJ T OM AT DIHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

CHROHIUH, DISS (MG/L-CR) COPPER, DISS (MG/L AS CU) LITHTUM, DISS (MG/L AS LI)

MOLYBRENUM, DISS (HG/L-HO)

COST: PROJECT: AST EDIT DATE: 01 FEB V2 OL FER 03 RY: TF *RCS PROCESSING PROGRAM: (11/3/81) PRINTEDE

> PERCENT HEO/L (FOR PIPER PLOT) MG CL 504 HC03 1.8 56.1 42.1 0.03 CA NA - 1 7.5 0.7 60.7 30.6

IN CORRESPONDENCE: PLEASE REFER TO LAB NUMBER: 8300003 NOTF: Reads

.001 .49 ,.003

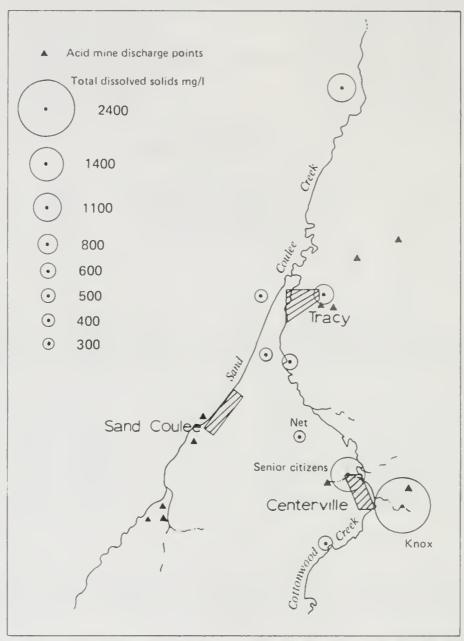
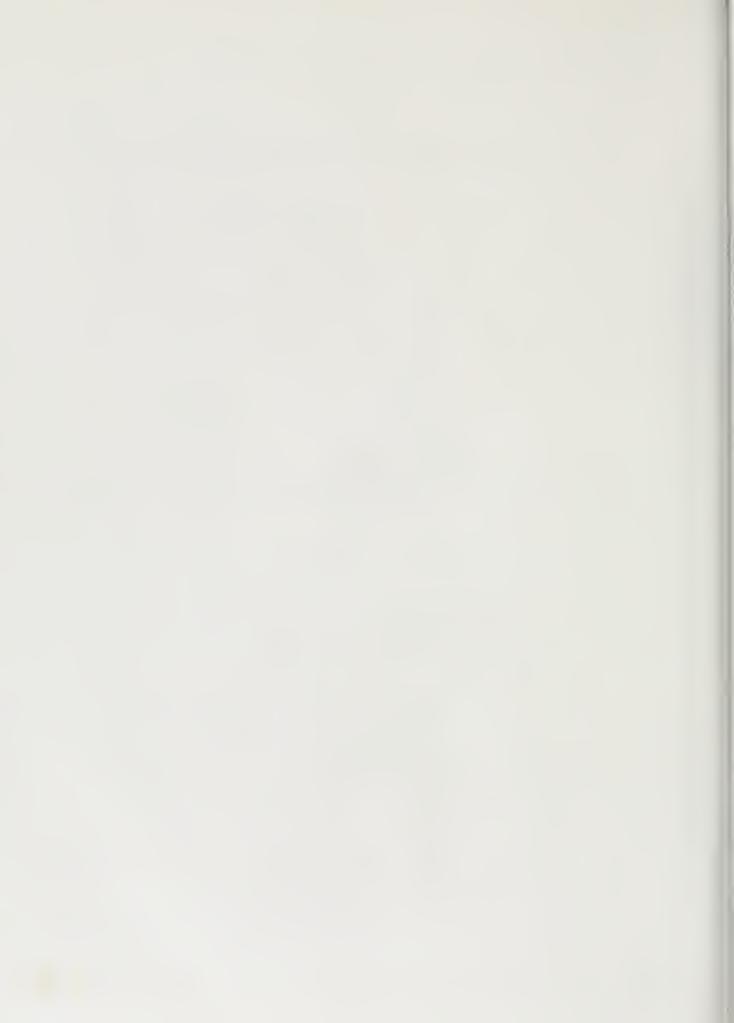


Figure C-3, Location of acid discharge points and total dissolved solids in Madison wells.

APPENDIX D
SURFACE WATER DATA



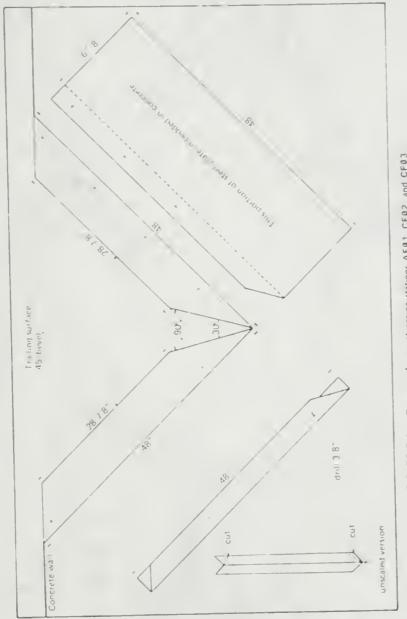


FIGURE D.1 Diagram of weir at gaging stations AFØ1, CFØ2, and CFØ3

The discharge rating equations are
For gage heights (g. h.) < 1.12ft. O(It³/s.) = 06672 * (g. h.)^{2.3}

For gage heights (g. h.) < 1.12ft. O(It³/s.) = [2.49 * ((g. h. - 0.8176)^{2.4.8})] * 0.7545

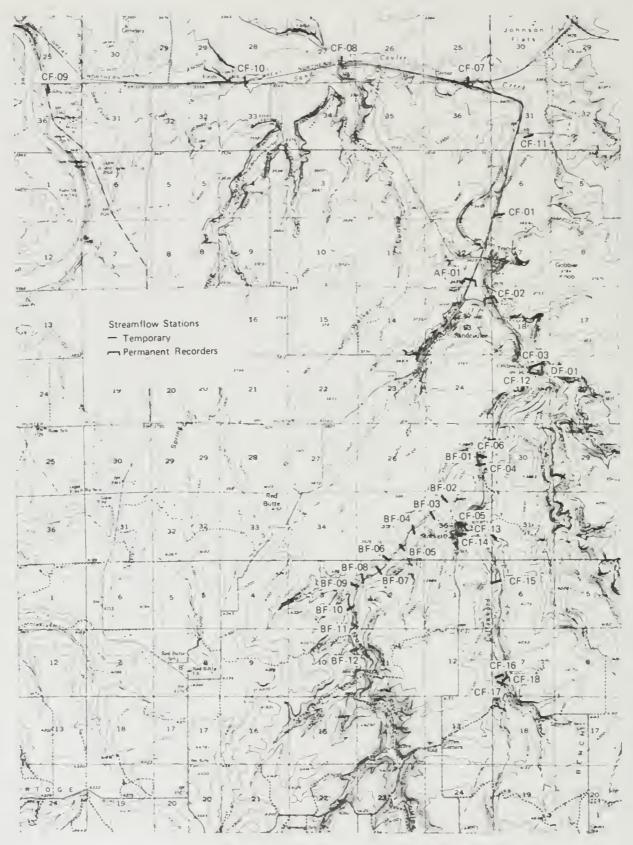


Figure D-2. Streamflow stations established for seepage profiling.

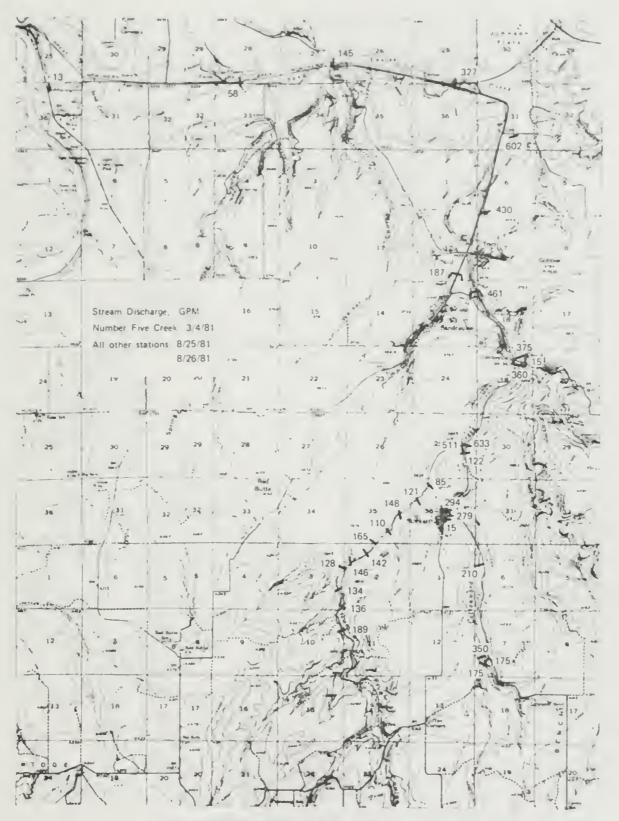


Figure D-3. Streamflow quantities measured in 1981.

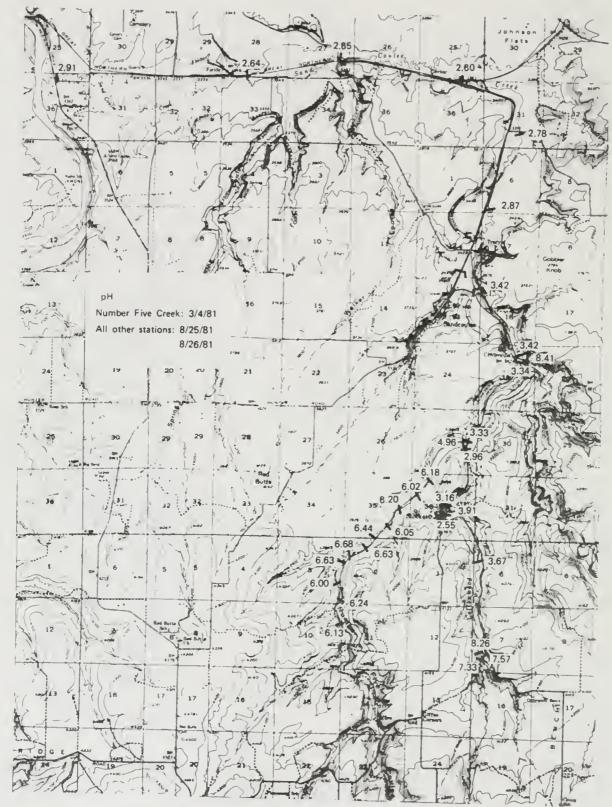


Figure D-4. Measurements of pH at the time of streamflow measurement.

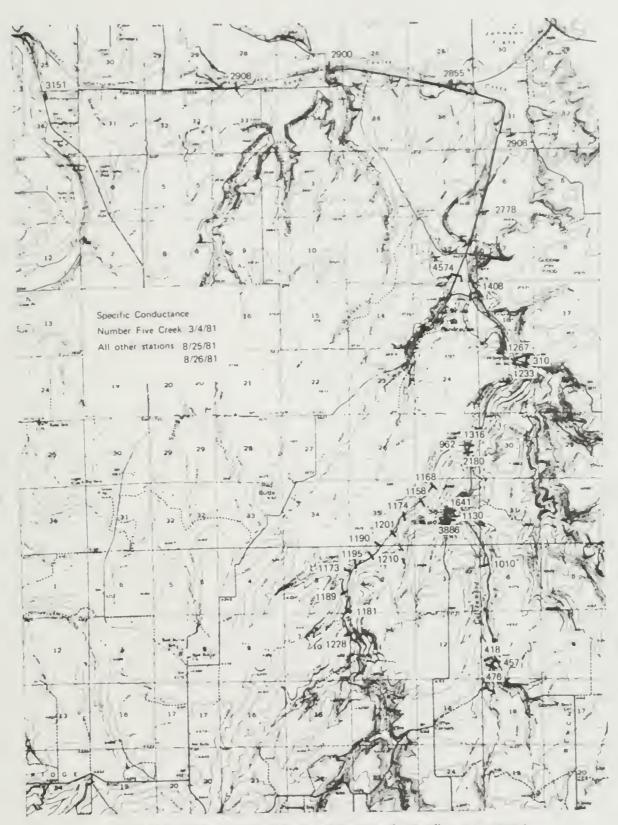
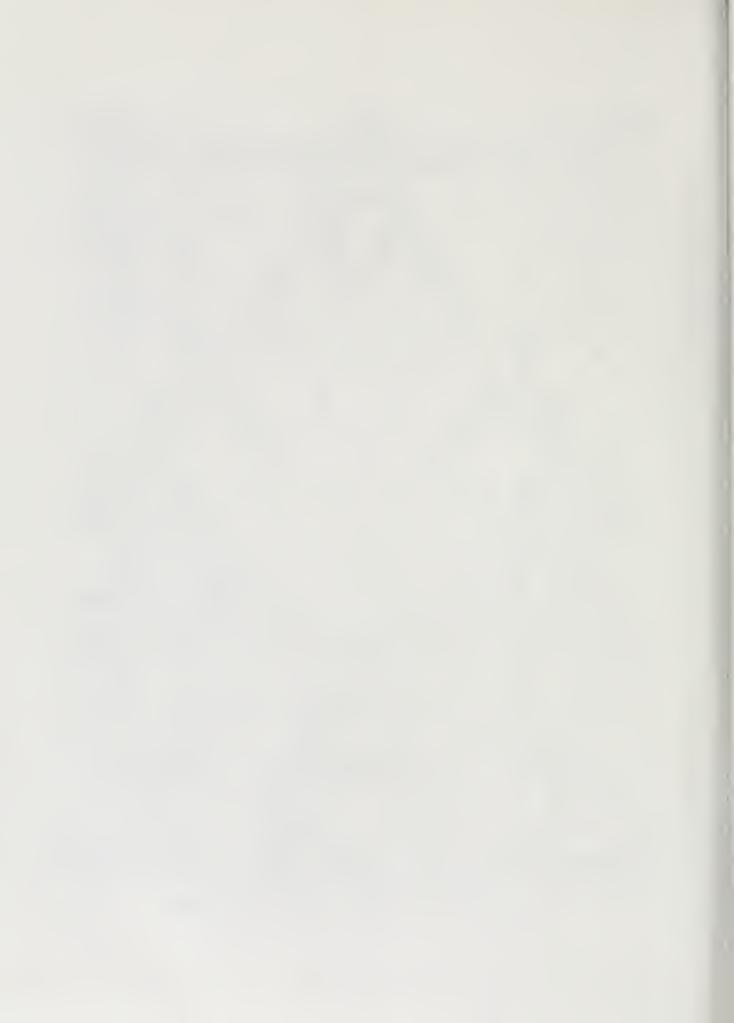


Figure D-5. Specific conductance values at the time of streamflow measurement.





WATER BUALTRY ANALYSTS LAR NO. 010:005

COUNTY CASCARE
SITE LOCATION 19N (3F 13 ARAB
MEMO SITE AF 01
STATION ID 472424111094701
SAMPLE SOURCE STREAM HONIANA 4/024/24'N 111009/42'W 712 NS250170 E48/795 SOUTHEAST GREAT FALLS 7 1 LATTIUMS LONGITUMS UTH COORDINATES TOPOGRAPHIC MAP GEOLOGIC SOURCE DRAINAGE BASIN * * TAND SURFACE ALTITUDE 34 WATER FLOW ROLE 5 FLOW MEAS METHOD WITH 3435. AGENCY I SAMPLER BOTH C NUMBER HERGMAIN GER Af 01 15 JUI DATE SAMPLED STAFF GASE STREAM STAGE 16:00 HOURS LAR ( ANALYST BAIC ANALYTED SAMPLE HANDLING BEIRGE SAMPLED REPTH TO SAMPLE TOTAL REPTH OF WATER STREAM WINTH ABBG*ENA GRAD

WATER USE UNUSER

SAMPLING SITE SAND COULEE MINING DISTRICT*NO NAME EREFR. DRAINAGE BASIN MISSOURI RIVER BETWEEN MARYAS RIVER AND LITTLE PRICELY PO

CALCIUM (CA) MAGNESTUM (MG) SODIUM (NA) POTASSIUM (K) IRON (FE) MANGANESE (HN) SILICA (SID2)	HO/L 137. 23.4 3.3 424. 455.4	11.27 1.02 0.08 22.78	BICARBONATE CARBONATE CHUCRIBE SULFATE NITRATE FLUORIDE PHOSPHATE TOT	(BCO3) (CO3) (CL) (SO4) (AS B) (F) (AS P)	#5/1 .0 7.5 3940. 2.10 7.14	0.71 02.03 0.15 0.30
TOTAL CATIONS		43.39	TOTAL	ANTONO		82.77

STANDARD DEVIATION OF ANION CATION BALANCE (SIGHA)

2.61 LARGRATORY FH TOTAL HARDNESS AS CACOS 573.40 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT LAB SPEC.COND.(HICROHOS/CH) TOTAL ALKALINITY AS CACOJ SOBJUM ADSORPTION RATIO RYZNAR STABLETTY INDEX 23.9 0.33 LANGLIER SATURATION THREY 4243.

PARAMETER	VALUE	PARAMETER	VALUE
TEMPERATURE, AIR (C)	25.	CHBUSTVY/ETELD HICROSHOS	3248.
FILL B. F.H.	3.00	ALUMINUM, DISS (MG/L AL)	2421
NICKEL, DISS (HG/L AS NI)	1.51	SILVER, BISS (MS/L AS AG)	.002
LEAD-DISS (HG/L AS PB)	04	BORGH PRISS (HG/L AS R)	.12
STRONTIUM, DISS (HS/L-SR)	1.07	CARMIUM, DISS(MS/L AS CD)	.011
TITANIUM DIS(MG/L AS TI)	.014	CHROMIUM, DISS (MG/L CR)	.012
VANARIUH, DISS (NG/L AS V)	.044	COPPER DISS (NO/L AS CU)	.013
LITHIUM (UISS(MG/L AS LI)	.52	HOLYDDENUH.DISS(HO/L HO)	,02
IRON, TR (HG/L AS FE)	421.	SELENIUM, TR (US/L AS SE)	. 0
ALUMINUH-TR (HG/L AS AL)	238.	ACIDITY, TOT (MG/L CACO3)	3070.
ZINC:DISS (HG/L AS ZN)	7.72	ZIRCONIUM BIS(MG/L AS ZR	003

REMARKS: WATER MUDDY AND RUSTY COLOR NO NAME CREEK GAGINS STATION AF-C1 LAR: H4 60.88 MG/L GIVES 80.25 MEQ. CATIONS GIVES 1.31 SIGMA

EXPLANATION: MG/L = MILLIGRAMS PER LIFER, UG/L = MICROGRAMS PER LIFER, MEG/L HILLIFQUIVELENTS PER LIFER. FT = FEEL, MT = MCTERS. (H) = MEACURER, (F) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

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OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST: LAGI FRIT RAIE: 12 FER 82 RY: PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTER: TO *JNS 27 MAY 83

> PERCENT HER/L (FOR PIPCE PLOT) 0.3 77.7 0.0 MG NA 37.3 54.3 5,0 0.4

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAR NUMBER: 6101005 D-6

### WATER QUALITY ANALYSIS LAB NO. 0101511

STATE HONTANA COUNTY CASCAME LATITURE-LONGITURE 4/D23/23*N | 111D08/24*W SITE LUCATION 19N SE 17 AACA) HRMG SITE CF-03 STATION ID 472323111082401 UTH COGREINATES TOPOGRAPHIC HAP 13 HAP SCUTHEAST GREAT FALLS 7 1 GEOLOGIC SOURCE DRAINAGE BASIN AGENCY & SAMPLER * SAMPLE SOURCE STREAM * LAND SURFACE ALTITUDE 34 WATER FLOW RATE 3 FLOW MEAS METHOD WEIR B.D FT < 1: 3464. NCY & SAMPLER BOITE NUMBER MXHG*JLS 375. GF H NUMBER CF-03 DATE SAMPLED 27-AUS-61 TIME SAMPLED 11:00 HOU LAB & ANALYST HUMG*ENA DATE ANALYZED SAMPLE HANDLING 4220 HETHOD SAMPLED GRAD STAFF GAGE STREAM STASE DEPTH TO SAMPLE TOTAL DEPTH OF WATER 11:00 HOURS 1.1 FT (H) STREAM WINTH

WATER USE UNUSED

SAMPLING SITE SAND COULEE CREEK AT CENTERVILLE SCHOOL *
DRAINAGE BASIN MISSOURI RIVER BETWEEN MARIAS RIVER AND LITTLE PRICKLY (

CALCIUM (CA) HAGNESIUM (MG) SODIUM (NA) POTASSIUM (K) IRON (FE) HANGANESE (MN) CILICA (SIO2)	MG/L 145. 58.0 15.2 4.9 10.1 .89	4.77 0.33 0.13 0.54	BICARBONATE CARRONATE CHLORIDE SULFATE NITRATC FLUORIDE PHOSPHATE TOT	(HC03) (C03) (CL) (S04) (AS N) (AS N)	MG/L .0 6.8 857. 1.75 1.43	0.17 17.84 0.14 0.08
TOTAL CATIONS		13.37	TOTAL	ANIONS		18.25

STANDARD DEVIATION OF ANION-CATION BALANCE (SIGNA)

LABORATORY PH 3.35 TOTAL HARDNESS AS CACO3 600.79
FIELD WATER TEMPERATURE 19.6 C TOTAL ALKALINITY AS CACO3
CALCULATED DISSOLVED SOLIDS SOLIDH ADSORPTION RATIO 0.27
SUM OF DISS. CONSTITUENT RYZNAR STABILITY INDEX
LAB SPEC.COND.(MICROMHOSZCM) 1567, LANGLIER SATURATION INDEX

PARAHETER	VACUE	PARAMETER	VALUE
TEMPERATURE, AIR (C)	22. 0	CNDUCTVY/FIELD HICROHHOS	1267.
FIELD FR	3.42	ALUBINUB: DISS (MG/L-AL)	37.6
NICKEL, DISS (MG/L AS NI)	. 50	SILVER:DISS (HG/L AS AG)	<.002
LEAD+BISS (MG/L AS PB)	<.04	BORON → DISS (MG/L AS B)	.05
STRONTIUM,DISS (HS/L-SR)	.42	CADMIUM, DISS(MG/L AS CD)	.016
TITANIUM DIS(MG/L AS TI)	.027	CHRCHIUH, DISS (MGZL-CR)	,010
-VANADIUM,DISS(MG/L AS V)	.012	COPPERIDISS (HG/L AS CU)	.008
ZINC, BISS (HG/L AS ZN)	3.77	LITHIUM, DISS (HG/L AS LI)	.005
ZIROGNIUH DISCHGZL AS ZR	+007	HOLYBRENUH, DISS(HG/L-HO)	.03
SELENJUM, DISS (USZL-SE)	. 7	ACIDITY, TOT (MG/L "CACOS)	313.

REMARKS: WATER IS BRIGHT ORANGE * ABUNDANT FE-HYDROXIDE FLOCOULENT *
HENG GAGING STATION CF-03 * 1 FILTER USED * FRESH FLOC BELOW DE-01
INFLOW *

LAB: HY 6.30 MG/L SIVVES 12.0 MER CATIONS GIVES -2.01 SIGNA

EXPLANATION: HGZL = HILLIGRAMS PER LITER, UGZL = HICROGRAMS PER LITER, HEQZL HILLIEQUIVELENTS PER LITER, FT = FEET, HT = HETERS, (M) = HEASURED, (E) = ESTIMATED, (R) = REPORTED, TR = TOTAL RECOVERABLE, TOT = TOTAL.

RW WASS NI OW PW AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 19-FER-82 BY: TF *JKS
PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT MEQ/L (FOR PIPER PLOT)
CA MG NA K CL 584 HC03 C03
56.6 37.3 5.2 1.0 1.1 78.7 0.0 0.0

NOTE: IN CORRESPONDENCE: PLEASE REFER TO LAB NUMBER: 8191511 D-7

WATER GUALTRY ANALYSIS LAE NO. BIRISIS

HONTANA

47D22/14'N (LINOY/28'W SITE LOCATION 12N 41 25 ADER

7 N E HRNG SITE CE OU
STOCKETT 7 1/2' STATION 18 4722141 1092301

* * SAMELE GOURLE STEERS

EANS SURFACE ALTITUSE 3522. FI 1
WATER FLOW RATE 535. 388 STATE MONTANA LATITURE LONGITUDE 47022'1 AL 2" AUCT: C UTH COORDINATES 7

10F0GRAPHIC MAP 510

SCOLOGIC SOURCE

DRAINAGE RASIN BB

AGENCY 1 SAMPLER MAP

DATE SAMPLED 22 HAP STOCKETT 7 1/2/ AND SURFACE ALTITUDE 35
WATCH FLOW HATCH SURFERING WELLS
STACE GACE
STREAM STAGE
DEPTH TO SAMPLE
TUTAL DEPTH OF WATER
STREAM WIDTH DOTTLE NUMBER OF 06

DATE SAMPLED 00 AUG 81

TIME SAMPLED 10:00 HOURS
LAR : ANALYZED

DATE ANALYZED

CAMPLE HANDLING 4220

METHOR SAMPLED COAD

WATER USE UNUSED

HETHOR SAMPLER GRAD

SAMELING SITE COTTONWOOD OR DELOW CONFLUENCE W/#5 CREEF# DRAINAGE BASIN MISSOURI RIVER BETWEEN MARIAS RIVER AND FILLE PRICKLY PO

CALCIUM (CA) MAGNESTUM (MG) SCHIUM (NA) FOTASSTUM (N) IRON (FE) MANGANESE (MN) SILICA (SIO2)	MG/I 132. 52.8 15.4 4.8 30.5 45.2	4.75 0.67 0.12 1.54	HITRATE	(F)	#6/1 850 1.33	17.70 2.15 0.07
TOTAL CATIONS		14.15	TOTAL	ANIONS		10.12

STANDARD BEVIATION OF ANION CATION BALANCE (SIGNA)

TOTAL HARDNESS AS CACOS LABORATORY PH 3.64 584.99 17.2 C TOTAL ALKALINITY AS GACOS SOBIUM ADSORPTION RATIO RYZNAR STABILITY INDEX 55. LANGLIER SATURATION (NDEX CALCULATED DISSOLVED SOLIDS 0.28 SUM OF BISS, CONSTITUENT SPEC.COND. (MICROMHOS/CM) 1499.

CARAMETER	VALUE	PARAMETER	VALUE
TEMPERATURE, AIR (C)	18. C	CHRUSTVY FIELD HICROHIOS	1316.
SISLE OH	3.33	ALUMINUM, DISS (MG/L AL)	33.7
NICKEL DISS (MS/L AS NI)	.07	SILVER, BISS (HSZL AS AS)	.002
LEAD-RISS (MG/L AS PR)	(.04	BORON FRISS (MG/L AS B)	.06
STRONTIUH, DISS (MG/L -SR)	. 40	CADHIUM - BISS (MG/L AS CE)	.017
TITANTUM DIS(MG/L AS TI)	.021	CHROMIUM, PISC (MG// CD)	.000
VANADIUM, DISS(MS/L AS V)	.006	corper, biss (hoze as ou)	.066
ZINC, DISS (MG/L AS ZN)	3.84	LITHIUM DISSING/L AS LI)	.083
ZIRCONIUM DISCHG/L AS ZR	.008	HOLYEDENUM, DISC(HG/L HO)	.03
SELENTURY DISS (UB/L-SE)	· 7	ACIDITY.TOT(MG/L CACO3)	270.

REMARKS: WATER IS BRIGHT DRANGE * ABUNDANT FE HYDROXIDE FLOCEUENT *
NO. FIVE CREEK FLOW 511 GPH, PH 4.26, S.C. 262 * COTTONWOOD CREEK
UPSTREAM FLOW 122 GPH, PH 2.96, S.C. 2180 *
LAB: H- 5.85 MG/L GIVES 18-3 MER CATIONS GIVES -43 SIGNA

EXPLANATION: MGZL = MILLIGRAMS PER LITER, UGZL = MICROGRAMS PER LITER, MIRLIMITED PER LITER. FT = FEET, MT = METERS. (M) = MEASURED. (F) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. 101 1016.

57 CU AT 37 MA ULY

OTHER AVAILABLE DATA DTHER FILE NUMBERS:

COST: PROJECT: 19 FEB 82 F1730F V2 (11/3/81) PROCESSING PROGRAM: 3 Y : TO *.H.S 27 HAY 83 PRIMERI

> PERCENT MERZE (FOR PIPER PLOT) CI SG4 HE03 NA 003 CA おG 1.0 1.7 70.8 38.1 9.9

DULY: IN CORRESPONDENCE, PLEASE RELIE TO LAR NUMBER: 0101512 (2)

# WATER QUALITY ANALYSIS LAB NO. 8101513

LATITURE LONGITURE MONTANA 47026/59*N COUNTY CASCABE 20N 5F CF-07 111D07124*W SITE LOCATION 36 AAA UTH COORDINATES HRMG SITE TUPOGRAPHIC HAP GEOLOGIC SOURCE - DRAINAGE BASIN 4472659111092401 STREAH 3382. FT < 10 327. GPM SAMPLE SOURCE SOUTHEAST GREAT FALLS 7 1 GERLOGIC * LAND SURFACE ALTITUDE 33.
WATER FLOW RATE 3.
FLOW HEAS HETHOD WETR
STAFF GAGE F: E: UNATURAL BASIN BE AGENCY : SAMPLER MBMG*JLS DOTTLE NUMBER CF-07 BAIE SAMPLED 28-AUG-81 TIME SAMPLED 11:00 HOURS LAB : ANALYST MBMG*FNA DATE ANALYZED SAMPLE HAMDLING 4220 BETHOM CAMPLED GRAD STREAM STAGE DEPTH TO SAMPLE TOTAL DEETH_OF_WATER 0.6 FT (H) SIREAH WIRTH HETHOD SAMPLED GRAD

WATER USE UNUSER

GAMPLING SITE SAND COULEE CREEK .5 HI E OF GERBER SIBING BRAINAGE BASIN HISSOURI RIVER BETWEEN HARIAS RIVER AND LITTLE PRICKLY PL

CALCIUM (CA) HAGNESIUM (MG) SODIUM (NA) POTASSIUM (K) IRON (FE) MANGANESE (MN) SILIFA (SID2)	MG/L 330. 91.8 17.0 3.4 196. 44.7	7.55 0.74 0.09 10.53	BICARBONATE CARBONATE CHLORIDE SULFATE HITRATE FLUGRIDE PHOSPHATE TOT	(HC03) (C03) (CL) (S04) (AS N) (AS P)	MG/L .0 11.0 13.00 1.07 5.75	0.31 47.89 0.00 0.30
CARTIONS LATED		26.75	TOTAL	ANTONS		48,50

STANDARR BEVIATION OF ANION-CATION BALANCE (SIGHA)

LABORATORY PH 2.89 TOTAL HARDNESS AS CACO3 777.37
FIELD NATER TEMPERATURE 17.0 C TOTAL ALKALINITY AS CACO3
CALCULATED DISSOLVED SOLIDS SODIUM ADSORPTION RATIO 0.27
SUB OF DISS, CONSTITUENT RYTNAR STABILITY INDEX
LAB SPEC.COND.(HICROBHOSZCH) 3306. LANGLIER SATURATION INDEX

PARAMETER	VALUE	PARAMETER	VALUE
TEHPERATURE, AIR (C)	18.0 0	CHRUCTVY, FIELD HICROMHOS	2855.
FIELD OH	2.6	ALUMINUH+ RISS (MG/L-AL)	203,
NICKEL: DISS (MG/L AS NI)	2.18	SILVER,DISS (HG/L AS AS)	.005
LEAD+DISS (MG/L AS PB)	< . 04	BORON → DISS (MG/L AS B)	, 1.4
STRONTIUM:DISS (MG/L-SR)	.66	CADMIUM, DISS(MG/L AS CD)	.045
TITANIUM DIS(MG/L AS TI)	.32	CHROMIUM: DISS (MG/L-CR)	.10
VANABIUM, BISS (MG/L AS V)	.015	COPPER,DISS (HG/L AS CU)	.19
ZINC:DISS (MB/L AS 7N)	9.19	LITHIUH, DISS(HG/L AS LI)	.20
ZIRCONIUM DISCHOZE AS ZR	.019	HOLYBRENUM BISS (HG/L-HB)	.00
SELENJUH: DISS (UGZL SE)	.7	ACIRITY, TOT (MG/L -CACO3)	1840.

REHARKS: WATER IS RED BROWN * LARGE PARTICULATE HYDROXIDE FLOCCULENT * LAR: H: 37.06 MG/L GIVES 53.11 MEQ CATIONS GIVES -5.13 SIGMA

EXPLANATION: HGZL = HILLIGRAMS PER LITER, UGZL = HICROGRAMS PER LITER, HEQZL HILLIFOUTVELENTO PER LITER. FT = FEET, HT = HETERS, (H) = HEASURED, (E) = ESTIMATED, (R) = REPORTED. <math>IR = TOTAL RECOVERABLE. TOT = TOTAL.

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OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST FRIT RATE: 19-FER-82 BY: TP *UKS
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-HAY 83

FERCENT MEQ/L (FOR PIPER PLOT)
CA MG NA K CL 984 HC03 C83
48.8 46.2 4.5 0.5 0.6 22.4 0.0 0.0

NOTE: IT CORRESPONDENCE. PLEASE REFER TO LAW NUMBER: BIRISIS D-9

### WATER QUALITY ANALYSIS LAE NO. BID1514

COUNTY CASCADE STATE HONTANA STATE FORMAL TO SELECT ON THE STATE OF THE S LATITUDE LONGITUDE 47076'58'N 111017'38'W UTH CUCKBINATES 10FOSRAPHIC MAP N SOUTHWEST GREAT FALLS 7 1 GEOLOGIC SOURCE DRAINASE RASIN * LAND SURFACE ALLITUDE NATER FLOW RATE FLOW HEAS METHOD WETE 1: F: NCY & SAMPLER BOTTLE NUMBER AGENCY MBMG # JJD 13. GFH CF-09 DATE SAMPLED TIME SAMPLED LAR + ANALYST DATE ANALYZED SAMPLE HANDLING STAFF GAGE 23 - AUG 81 16:00 HOURS HRHG*FNA STREAM STAGE DEPTH TO SAMPLE TOTAL DEPTH OF WATER run Elun .1 FT (H) SIREAH WIDTH HETHOD SAMPLED GRAD

WATER USE UNUSED

SAMPLING SITE SAND COULEF CR#BRIDGE AT MISSOURT RIVER BB BRAINAGE BASIN MISSOURI RIVER RETWEEN MARIAS RIVER AND LITTLE PRICELY D

CALCIUH (CA) MAGNESIUM (MG) SODIUM (NA) POTASSIUM (K) IRON (FE) MANGANESE (MN) SILICA (SIO2)	MB/I 181. 86.3 38.8 7.9 15.7 1.79 27.1	7.10 1.69	CHIORIDE SULFATE HITRATE	(HCO3) (CO3) (CL) (SO4) (AS N) (F) (AS P)	MG/I .0 .0 .0 1490. .74 3.41	0.64 31.02 0.05 0.18
TOTAL CATIONS		18.93	TOTAL.	SHOTHA		31.87

STANDARD DEVIATION OF ANION CATION BALANCE (SIGMA)

LABORATORY PH 3.27 TOTAL HARDNESS AS CACO3 807.17
FIELD WATER TEMPERATURE 13.2 C TOTAL ALKALINITY AS CACO3
CALCULATED DISSOLVED SOLIDS SOMIUM ADSORPTION RATIO 0.57
SUM OF DISS. CONSTITUENT RYZNAR STABILITY INDEX
LAB SPEC.COND.(MICROMHOS/CM) 2348. LANGLIER SATURATION INDEX

PARAMETER TEMPERATURE, AIR (C) FIFLE PH MICKEL, DISS (MG/L AS NT) LCAD, DISS (MG/L AS PR) STRONTIUM, DISS (MG/L AS TI) TITANIUM DISS (MG/L AS TI) VANADIUM, DISS (MG/L AS V) ZINC, DISS (MG/L AS ZN)	VALUE 25. C 2.71 1.37 1.04 .75 .033 .004 5.48	PARAMETER CNDUCTVY, FIELD HICROMHOS ALUMINUM, DISS (MG/L-AL) SILVER, DISS (MG/L AS AG) BORON , DISS (MG/L AS A) CADMIUM, DISS (MG/L AS CD) CHROMIUM, DISS (MG/L AS CD) COPPER, DISS (MG/L AS CU) LITHIUM, DISS (MG/L AS LI)	VALUE 3151. 117. 002 .1021 .0312 .118
	* O O C		

REMARKS: WATER IS TURBID, HURKY, ALGAE-RICH * LARGE FLOCCULENTS OF ORANGE FE-HYDROXIDE PRECIPITATE * RANKS % BED RICH IN FE-HYDROXIDE HUD DEPOSITED AFTER HAY FLOOD * HIGH WATER P 5.4 ABOVE CHANNEL * LAB: HE 16.31 HG/L GIVES 34.21 HED CATIONS GIVES 3.7 SIGNA

EXFLANATION: MG/L = MILLIGRAMS PER LITER, MG/L = MICROGRAMS PER LITER, MEG/L HILLIEUUIVELENTS PER LITER, FT = FEFT, MT = METERS. (M) = MEASURED, (F) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

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OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST FDII DATE: 19-FCD 62 RY: IF *JKS
PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTED: 27-MAY-M3

PERCENT HEQ/L (FOR PIPER PLOT)
CA MG NA K CL SO4 HCO3 CO3
50.1 37.4 7.4 1.1 2.0 28.0 0.0 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 0101516 D-10

MONTANA RUREAU OF MINES AND GEOLOGY DUTTE, HONTANA 59701 (406)496-4101

WATER QUALITY ANALYSIS LAB NO. 81G1514

STREAM WIRTH

COUNTY CASCADE

1/24'W SITE LOCATION 19N 5E 19 AACD

MRMG SITE CF-12

ALLS 7 1 STATION ID 472320111002401

* SAMPLE SOURCE STREAM

LAND SURFACE ALTITUDE 3464. FT < 1

WATER FLOW RATE 360,0 GPM
FLOW HEAS HETHOD ESTIMATED

STAFF GAGE STATE LATITUDE - LONGITUDE AGNTANA 47D23'20"N 111D0B'24"W UTH COUNTY TOPOGRAPHIC MAP SOLUTION OF TOPOGRAPHIC MAP SOLUTION OF THE SOLUTIO SOUTHEAST GREAT FALLS 7 1 * < 10 BOTTLE NOTBER CF-1
DATE SAMPLED 27-A
TIME SAMPLED 12:0
LAR + ANALYST MRMG
DATE ANALYZED
SAMPLE HANDLING 4220 STREAM STAGE DEPTH TO SAMPLE TOTAL DEPTH OF WATER

-WATER USE UNUSED

HETHOD SAMPLED GRAD

SAMPLING SITE COTTONWOOD CREEK * AT CENTERVILLE SCHOOL DRAINAGE BASIN MISSOURI RIVER BETWEEN MARIAS RIVER AND LITTLE PRICKLY F

CAUCIUM (CA) MAGNESIUM (MG) SUBIUM (NA) POTASSIUM (K) IRON (FE) MANGANESE (MN) SILICA (SIB2)	60.1 15.8 5.1 7.60	7.53 BIC 4.94 CAR 0.69 GRL 0.13 SUL 0.52 HIT 0.03 FLU	ORIDE	(F)	MG/L +0 6.7 891. 2.04 1.44	0.17 18.55 0.15 0.08
TOTAL CATIONS	1.7	8.85	TOTAL	ANIONS		18.76
STANDARD DEVIAT	ION OF ANION-	CATION	BALANCE	(SIGHA)		
LAROR FIELD WATER TE		3.50 12.2 C T	TOTAL HARI			24.42

CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT SORIUM AUSORPTION RATIO 0.28 RYZNAR STABILITY INDEX SPEC.COND. (HICROMHOS/CH) LANGLIER SATURATION INDEX 1598.

PARAHETER	VALUE	PARAMETER	VALUE
TEMPERATURE, AIR (C)	22.	CNDUCTVY+FIELD HICROHHOS	1233.
FIELD OH	3.34	ALUMINUM, DISS (MG/L-AL)	43.3
NICKEL/BISS (MG/L AS NI)	, 72	SILVER-DISS (MG/L AS AG)	1002
LEAD, BISS (MG/L AS PB)	<.04	BORON +DISS (MG/L AS B)	.04
STRONTIUM:DISS (MS/L-SR)	:42	CADHIUH, DISS(HG/L AS CD)	.015
TITANIUM DIS(MG/L AS TI)	• ଡ଼ପ୍ତ	CHROHIUH, DISS (HG/L-CR)	.014
VANADIUH, DISS (HG/L AS V)	• 005	COPPER DISS (NG/L AS CU)	.030
ZINC+DISS (MG/L AS ZN)	-3.04_	LITHIUH, BISS (HG/L AS LI)	.087
ZIRODNIUM DISCHOZE AS ZR	, 003	HOFABDENAR DISS(ROVE - HO)	.02
SELENIUM: DISS (UG/L-SE)	• 8	ACIBITY, TOT (MG/U-CACO3)	340.

REMARKS: FLOW BY SUBTRACTION FROM CF-03 WEIR (DF-01=CA:15 GPH) *

HORE COMPACT FLOCHUSED 2 FILTERS
LAB: H+ 6.90 HS/L GIVES 20.1 HER CATIONS GIVES -2.9 SIGHA

EXPLANATION: HGZU = HILLIGRAHS PER LITER, UGZU = HICROGRAHS PER LITER, HERZU: HILLIERUIVELENTS PER LITER. FT = FEET, HT = HETERS. (H) = HEASURED, (F) = ESTIHATER. (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

RW WA SO WI OW FW AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: BYI TP *JKS LAST EDIT DATE: 17-FEB-82 PROCESSING PROGRAM: F1730P V2 (11/3/B1) PRINTED: 27-HAY-83

> PERCENT HEQ/L (FOR PIPER PLOT)
> CA HG NA K DL 904 HC03
> 56.7 37.2 5.2 1.0 1.0 99.0 0.0 NA K CÉ S04 HC03 CD3 5.2 1.0 1.0 27.0 0.0 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8101514 D-11

# WATER QUALITY ANALYSIS

STATE HONTANA COUNTY CASCADE 47015'23'N LILDOS'05'W STIF LOCATION E MRHG SITE 1 BH LATTIUME - LONGITUME 7#CCAA 5,1 UTH COORDINATES MRHG SITE CF 16 STATION IN 471923111090501 STOCKETT 7 1/2' TOPOGRAPHIC MAF SECTORIC SOURCE DRAINAGE BASIN GENCY + SABELER BOTTLE NUMBER STREAM 3855. LAND SURFACE ALTITUDE * E: F: FT 10 WATER FLOW RATE FLOW HEAS HETHOD STAFF GAGE 350.0 GPH AGENCY HRMG*.ILS CF-16 SAHELED 28 AUG B1 DATE STREAM STAGE DEPTH TO SAMPLE TOTAL DEPTH OF WATER TIME SAMPLED 18:00 HOURS LAR 1 ANALYST HRHG*FNA DATE ANALYZED 25 SEP 81 SAMPLE HANDLING 4220 0.6 FT (H) STREAM WIDTH HETHOD SAMPLED GRAD

WATER USE UNUSED

GAMPLING SITE COTTONWOOD CREEK * BELOW BILL SHIRLEY FARM DRAINAGE BASIN HISSOURI RIVER BELWEEN MARIAS RIVER AND LITTLE PRICKLY P

SODIUM (NA) POTASSIUM (K) IRON (FE) MANGANESE (MN)	56.7 34.1 11.4 3.1	2.83 2.81 0.50 0.08 0.02 0.00	BICARBONATE CARBONATE CHLORIDE SULFATE NITRATE FLUORIDE PHOSPHATE TOT	(HCO3) (CO3) (CL) (SO4) (AS N) (E)	MG/I 235. 0. 3.7 49.1 5.33	0.10
TOTAL CATIONS		6.23	TOTAL	ANIONS		6.21
STANDARD REVIATI	ON OF ANI	ON-CATI	ON BALANCE	(SIGHA)	0.1	0
LABORA FIELD WATER TEME CALCULATED DISSOLVED SUM OF DISS. CONS LAB SPEC.COND.(HICRO)	YERATURE   SOLIDS   STITUENT	313.13 457.73	TOTAL HAR DARLA JETOT O DARLA HULDOS RYZNAR S LANGLIER SA	INITY AS SORPTION TABLLITY	CACO3 RATIO INDEX	281.94 233.75 0.30 4.50 0.88
PARAMETER TEMPERATURE, AIR (C) ALUMINUM, RISS (MG/L-4 SILVER, DISS (MG/L AS A RORON , DISS (MG/L AS C CADMIUM, DISS (MG/L AS C CHROMIUM, DISS (MG/L-6 COPPER, DISS (MG/L-6 LITHIUM, RISS (MG/L AS C LITHIUM, RISS (MG/L-6 MOLYBDENUM, DISS (MG/L-6 SELENIUM, TR (UG/L AS C	20 AL) AG)	.31 .002 .07 .002 .002 .002 .003 .003	PARAM CHRUCTVY,FIF HICKEL,RISS LEAD, DISS (STRONTIUM, DI TITANIUM BIS VANABIUM, DI ZINC, DISS (ZIRCONIUM DI SELENIUM, DI	LD HICROH (HG/L AS HG/L AS F SS (HG/L AS (HG/L AS S(HG/L AS HG/L AS Z	(HOS (NI) (NI) (R) (SR) (TI) (TI) (TV) (TV)	VALUE 770.02 .02 .04 .27 .003 .013 .003

REHARKS: WATER IS HURKY, SOME FE-HYDROXIDE PRECIPITATES*HUDDY COLOR*REQUIRED : FILTERS*BELOW CONF OF STREAM THRU SHIRLEY RANCH AND ACID STREAM DRAIL ING RESERVOIR*FH HIGHLY DNSTABLE * ELECTRODE POISONS*CROSS REF 81016:

EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, HEG/L HILLIEGUIVELENTS PER LITER. FT = FEET, H1 = HETERS. (H) = HEASURER, (E) = ESTIMATED, (R) = REPORTED. IR = TOTAL RECOVERABLE. TOT = TOTAL.

RW WA S2 NI OW PN AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

TASECCUL

PROJECT: COST: COST: LAST FRIT RATE: 25-NOV-81 BY: TF *TF PROCESSING PROGRAM: F1730F V2 (11/3/81) FRINTED: 27 MAY-83

PERCENT HER/L (FOR FIFER PLOT)
CA HG NA K CL 904 HC03 C03
45.5 45.2 8.0 1.3 1.8 17.5 80.5 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAR NUMBER: 8101515 D-12

WATER QUALITY ANALYSIS LAB NO. 8101517

STREAM WIDTH

SELENIUM, TR (UG/L AS SE)

STATE MONTANA COUNTY CASCADE SITE LOCATION 19N 5E 19*AACD (
HRMG SITE DF-01
STATION ID 472321111082101
SAMPLE SOURCE STREAM 47D23'21"N 111D08/21*W LATITUDE - LONGITUDE # SAMPLE SOURCE
LAND SURFACE ALTITUDE
WATER FLOW PATE
FLOW UTH COORDINATES TOPOGRAPHIC HAP N SOUTHEAST GREAT FALLS 7 1 GEOLOGIC SOURCE DRAINAGE BASIN * * 3464. BASIN WATER FLOW RATE 15. FLOW HEAS HETHOD ESTINATED NCY + SAMPLER BOTTLE NUMBER GPH HBHG*JLS AGENCY DF-01 27-AUG-81 10:30 HOURS DATE SAMPLED TIME SAMPLED STREAM STAGE LAR + ANALYST MBMG*FNA DATE ANALYZED 12-0CT-81 SAMPLE HANDLING 4220 DEPTH TO SAMPLE TOTAL DEPTH OF WATER

WATER USE UNUSED

METHOD SAMPLED GRAD

SAMPLING SITE SAND COULEE CR*UPSTREAM FROM COTTONWOOD CR DRAINAGE BASIN MISSOURI RIVER BETWEEN MARIAS RIVER AND LITTLE PRICKLY PO

CALCIUM (CA) MAGNESIUM (MG) SODIUM (NA) POTASSIUM (K) IRON (FE) MANGANESE (MH) SILICA (SIO2)	8. 3.4	1.66   2.47   0.35   0.00   0.00	BICARBONATE CARBONATE CHLORIDE SULFATE NITRATE FLUORIDE PHOSPHATE TOT	(CO3) (CL) (SO4) (AS N) (F)	MG/L 155.2 0. 2.8 94. .05	HEQ/L 2.54 0.00 1.96 0.00 0.03
TOTAL CATIONS		4.56	TOTAL	ANIONS		4.61
STANDARD DEVIAT	ION OF AND	ON-CATIO	ON BALANCE	(SIGMA)	0.26	
LABOR FIELD WATER TEM CALCULATED DISSOLVE SUM OF DISS. CON LAB SPEC.COND.(MICRO	PERATURE D SOLIDS STITUENT	25.0 ( 252.51 331.26		INITY AS SORPTION TABILITY	CACO3 1 RATIO INDEX	06.38 27.29 0.24 7.79 0.09
PARAMETER TEHPERATURE, AIR (C) FIELD PH NICKEL, DISS (MG/L AS F STRONTIUM, DISS (MG/L AS F STRONTIUM DISS (MG/L AS V ANADIUH, DISS (MG/L AS Z ZIRCONIUM DISS (MG/L AS Z	22 NI) (B) (S) (S) (SE) (TI) (S) (V) (S) (N) (S)	ALUE 2.0 C .41 .02 .04 .55 .001 .006 .003	PARAH CNDUCTVY, FIEL ALUHINUM, DIS SILVER, DISS BORON, BISS CADHIUH, BISS CHROMIUH, BIS COPPER, DISS LITHIUH, BISS HOLYBDENUM, DI	SS (MG/L- (MG/L AS (MG/L AS (MG/L AS SS (MG/L- (MG/L AS (MG/L AS (MG/L AS (MG/L AS	(HOS 3 -AL) AG) B) CD) -CR) CU) LI) -MO)	ALUE 7028 <.002 <.002 <.002 <.002 .007 <.02

REMARKS: USED 6 FILTERS - 80-100 HL/FILTER * GEL-LINE PPT. ON FILTER (SOAP?) * CROSS REF. 8181839 *

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L MILLIERUIVELENTS PER LITER. FT = FEET, MT = METERS, (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

82 WI PW GM WA ถผ AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

SELENIUM, DISS (UG/L-SE)

COST: PROJECT: 25-NOV-81 TP *TP PROCESSING PROGRAM: F1730F V2 (11/3/81) 27-HAY-83 PRINTED:

. 4

PERCENT HER/L (FOR PIPER PLOT) CA HG NA K CL SO4 HCO3 0.03 1.7 42.7 55.5 7.6 1.7 36.3 54.1 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8181517 Reads

### D-7

# DAILY DISCHARGE DATA AND STREAMFLOW HYDROGRAPHS

## Stations:

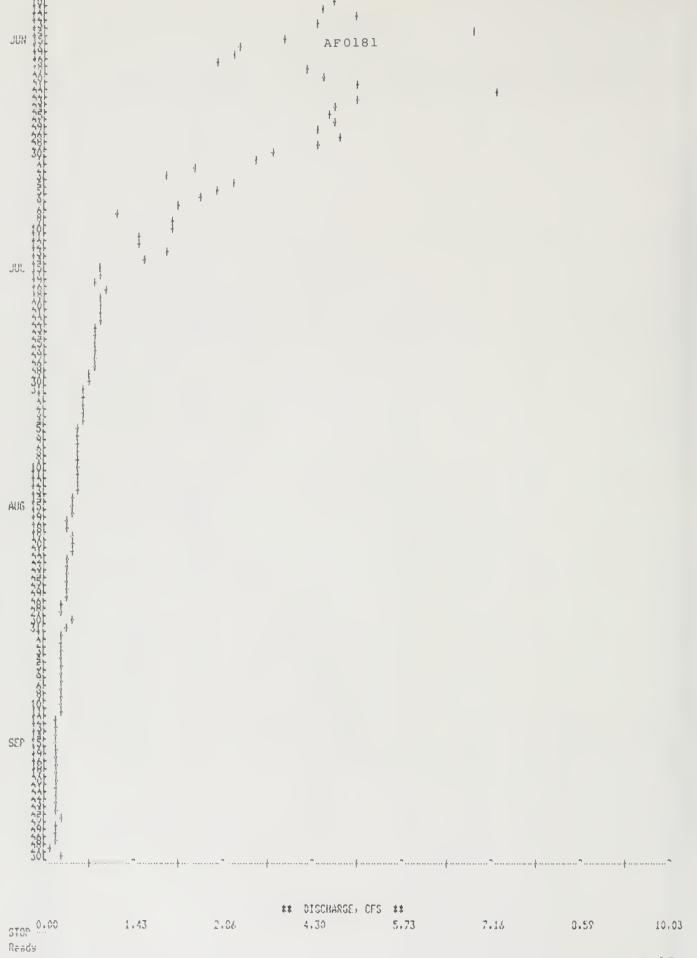
AF01 CF02 CF03



	TION AF018 YEAR FROM			CREEN NEAR 1981			0 12 0000	1	LAI 0 0	O K LONG	0 0 0	Si Si
DAY	OCT	NOV	DEC	Jan	EEB	MEAN DIS	CHARGE, CFS APR	mAY.	JUN	JUL	AUG	SEF.
12345	111111111	14411144 14444444 144444444 144444444 1444444	0.000 0.000 0.000 0.000 0.000	0.000 0.002 0.004 0.003 0.004	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.137 0.031	7.504 6.003 3.455 1.890 1.801	1.635 1.668 1.523 1.523 1.720	5.067 5.391 5.041 5.214 5.020	3.433 2.442 2.015 3.100 2.843	0.701 0.673 0.351 0.663 0.618	0.347 0.293 0.293 0.325 0.325
6 7 8 9	***************************************	0.099 0.109 0.101 0.071 0.064	0.000 0.000 0.000 0.000 0.055	0.017 0.015 0.017 0.043 0.006	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	1.660 1.562 1.500 1.132 1.417	1.989 2.010 4.805 1.969 1.791	4.935 4.688 4.607 4.935 4.668	2.574 2.175 1.252 2.104 2.067	0.610 0.606 0.616 0.610 0.583	0.312 0.273 0.274 0.283 0.283
11 12 13 14 15	:::::::::::::::::::::::::::::::::::::::	0.049 0.028 0.004 0.000 0.000	0.190 0.051 0.029 0.080 0.214	0.008 0.011 0.009 0.008 0.005	0.000 0.000 0.018 0.378 0.344	0.000 0.000 0.000 0.000	1.326 1.276 1.184 1.163 1.206	1.905 2.400 2.236 2.067 2.772	4.527 5.031 4.449 6.958 3.879	1.577 1.577 1.994 1.660 0.955	0.575 0.568 0.549 0.534 0.520	0.274 0.264 0.264 0.254 0.254
16 17 18 19 20	********** ********* *********	0.001 0.010 0.009 0.007 0.004	0.034 0.000 0.000 0.000 0.000	0.000 0.002 0.121 0.136 0.064	0.270 0.039 0.012 0.000 0.000	0.000 0.000 0.000 0.000 0.000	1.229 1.326 1.352 1.406 1.434	7.760 3.235 6.579 6.414 6.515	3.198 3.078 2.793 4.294 4.527	0.949 0.333 1.009 0.932 0.911	0.449 0.427 0.444 0.448 0.461	0.254 0.245 0.236 0.236 0.227
21 22 23 24 25		0.037 0.000 0.001 0.033 0.000	0.000 0.000 0.000 0.000 0.324	0.027 0.007 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.000 0.000 0.053 0.053 0.468	1.500 1.685 1.538 1.554 1.463	9.557 10.026 7.975 7.701 7.434	5.084 7.337 5.020 4.738 4.607	0.899 0.896 0.888 0.880 0.883	0.458 0.409 0.394 0.400 0.431	0.236 0.227 0.210 0.210 0.342
26 27 28 29 30 31		0.011 0.050 0.049 0.024 0.003 0.000	0.318 0.086 0.002 0.003 0.000	0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.893 1.835 1.764 2.495 4.713 8.450	1.585 1.554 1.523 1.685 1.651 0.000	7.518 6.489 6.338 5.923 5.734 7.490	4.708 4.419 4.769 4.449 2.699 0.000	0.880 0.835 0.813 0.795 0.749 0.699	0.431 0.389 0.336 0.336 0.451 0.436	0.231 0.199 0.195 0.151 0.314 0.000
HEAN HAX HIN	::::::::: ::::::::::::::::::::::::::::	********* 0.109 0.000 ********	1.385 0.045 0.324 0.000 2.747	0.507 0.016 0.136 0.000 1.006	1.090 0.039 0.378 0.000 2.163	20.892 0.674 6.450 0.000 41.439	56.553 1.835 7.504 1.122 112.172	151.753 4.875 10.026 1.523 300.997	142.171 4./39 7.337 2.793 281.993	45.706 1.474 3.433 0.627 90.657	15.781 0.509 0.701 0.336 31.302	7.854 0.762 0.347 0.151 15.578

## DISCHARGE, CFS ## 10,03 2,86 7,16 8,57 1,43 4,30 OCT HOV DEC JAN

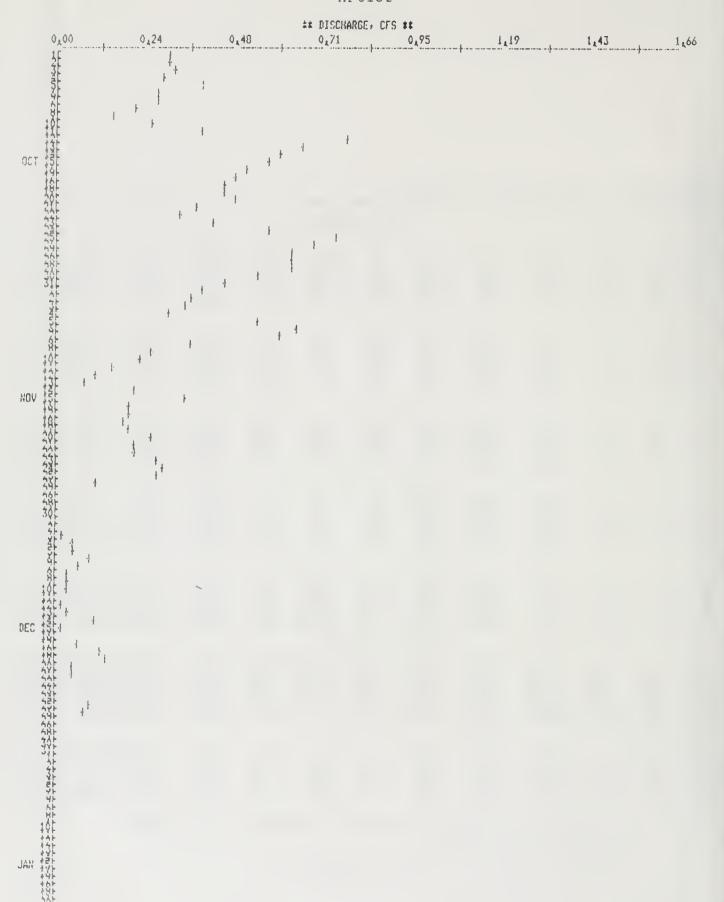
AF0181 HAR HAY D-16

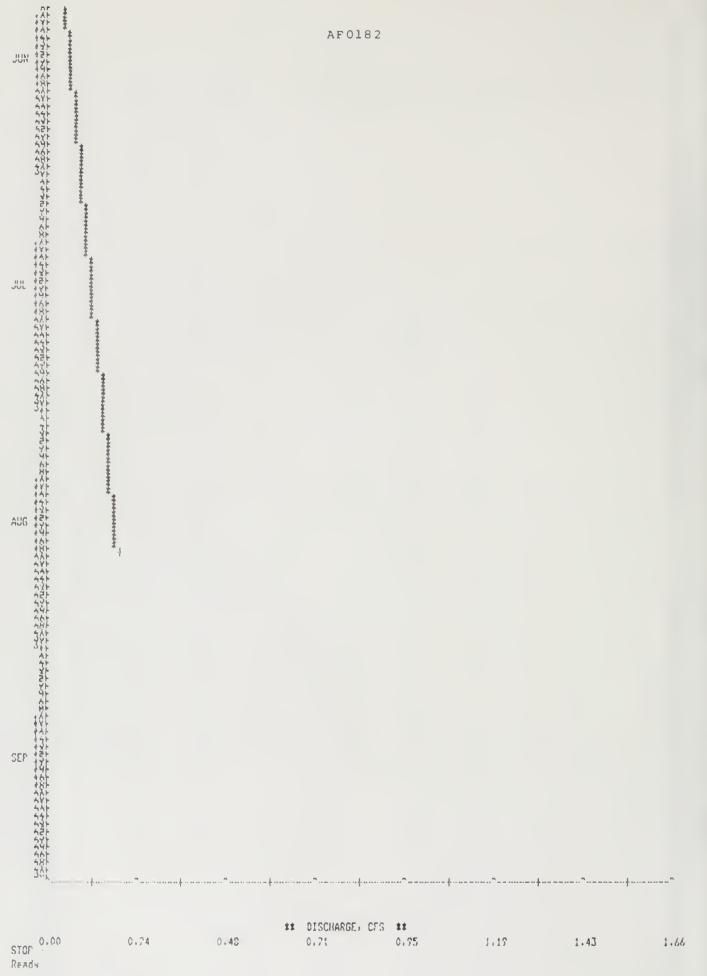


	ION AF0182 YEAR FROM			CREEK NEAR 1982	SAND COULE T 19N		12 PCDC	LA	1 0 0 0	N LONG	0 0 0	) la
DAY	OCT	NOV	DEC	JAN	LEB	MEAN BISCH	HARGE, CFS 1 APR	nAY	JUN	JUL	AUG	SEF
1 2 3 4 5	0.304 0.304 0.314 0.293 0.389	0.374 0.359 0.347 0.306 0.549	0.000 0.000 0.026 0.047 0.058	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.325 0.119 0.048 0.110 0.148	0.0623 0.0738 0.0833 0.094 0.012	0.038\$ 0.040\$ 0.042\$ 0.044\$ 0.046\$	0.0973 0.0993 0.1013 0.1032 0.1053	0.1608 0.1628 0.1648	1111111111 1111111111 1111111111 111111
6 7 8 9	0.274 0.269 0.210 0.155 0.259	0.641 0.597 0.358 0.254 0.228	0.095 0.072 0.032 0.033 0.031	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.263 0.003 0.166 0.316 0.736	0.162 0.105 0.070 0.130 0.109	0.048* 0.050* 0.052* 0.054* 0.056*	0.107* 0.107* 0.111* 0.113* 0.115*	0.170: 0.172: 0.174:	
11 12 13 14 15	0.391 0.781 0.667 0.602 0.572	0.162 0.116 0.087 0.210 0.344	0.014 0.017 0.030 0.108 0.024	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.092 0.106 0.127 0.104 0.038	1.564 0.795 0.809 0.587 0.476	0.016 0.004 0.001 0.003\$ 0.005\$	0.058; 0.060; 0.062; 0.064; 0.066;	0.117\$ 0.119\$ 0.121\$ 0.123\$ 0.125\$	0.180± 0.182± 0.184±	11:11:11:11:11:11:11:11:11:11:11:11:11:
16 17 18 19 20	0.513 0.485 0.458 0.456 0.490	0.194 0.202 0.186 0.202 0.253	0.010 0.073 0.124 0.137 0.056	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.008 0.009 0.003 0.000 0.099	0.657 0.328 0.277 0.321 0.431	0.007\$ 0.009\$ 0.011\$ 0.013\$ 0.015\$	0.068\$ 0.070\$ 0.072\$ 0.074\$ 0.076\$	0.127\$ 0.129\$ 0.131\$ 0.133\$ 0.135\$	0.1903 0.1923 0.194	111111111
21 22 23 24 25	0.373 0.330 0.419 0.573 0.756	0.214 0.219 0.269 0.263 0.283	0.054 0.010 0.013 0.001 0.091	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.054 0.260 0.290 0.136 0.086	0.261 0.069 0.033 0.034\$ 0.035\$	0.017\$ 0.019\$ 0.020\$ 0.022\$ 0.024\$	0.0782 0.0802 0.0823 0.0842 0.0862	0.139\$ 1 0.141\$ 1 0.143\$ 1		1811111111 1811111111 1811111111 18111111
26 27 28 29 30 31	0.684 0.634 0.634 0.634 0.542 0.458	0.119 0.010 0.000 0.000 0.000 0.000	0.079 0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000 0.000	0.150 0.326 0.723 0.732 0.354 0.293	0.0368 0.0388 0.0398 0.040 0.0518 0.000	0.026\$ 0.028\$ 0.030\$ 0.032\$ 0.034\$ 0.036\$	0.087\$ 0.089\$ 0.091\$ 0.093\$ 0.095\$ 0.000	0.1498 0.1518 0.1538 0.1548		22222222 22222222 22222222 22222222 2222
TOTAL NEAN HAX HIN AC-FT	14.223 0.459 0.781 0.155 28.211	7,386 0,246 0,641 0,000 14,650	1.235 0.040 0.137 0.000 2.450	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	3.999 0.129 0.732 0.000 7.932	9.213 0.307 1.664 0.003 18.274	1.271 0.041 0.162 0.001 2.521	2.004 0.067 0.095 0.030 3.975	0.127 0.156 0.097	0.194	0.000

Record accuracy affected by siltation and corrosion of weir plate, worsening throughout year.

^{*} Interpolated value.



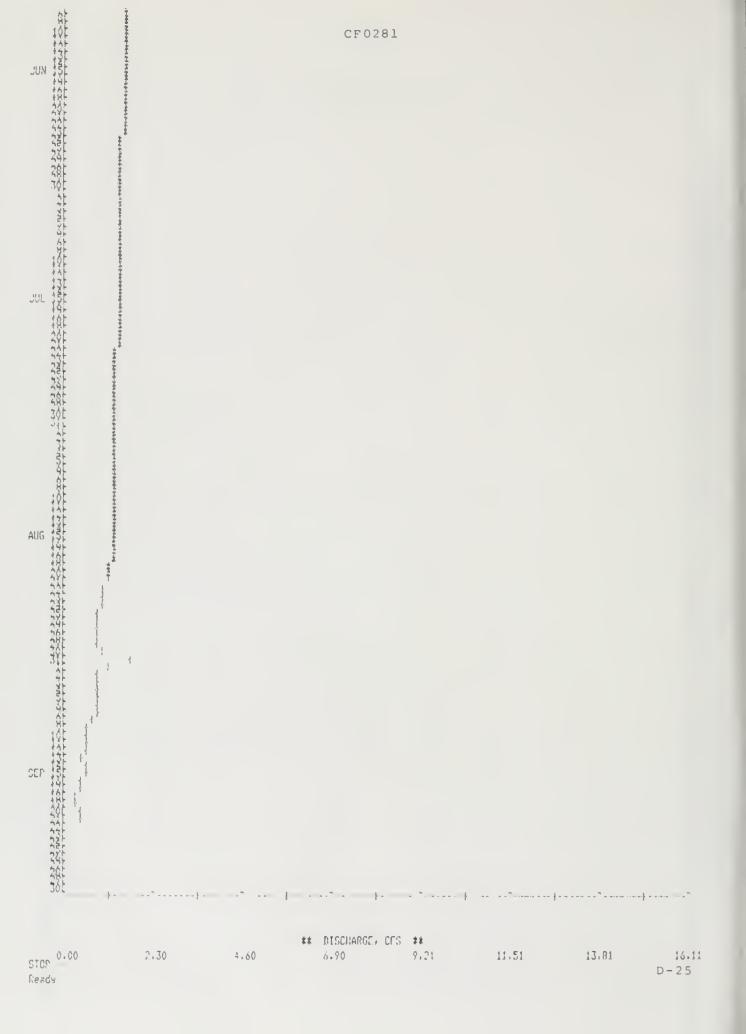


	TION CF028. YEAR FROM		SAND COULEE 18 OCT 1 19	CREEK NEAR		NT. R OSE SEC	19 AACA	LA	AT 0 0	O H LONG	0 0	0 ₩
DAY	OCT	HOV	DEC	JAN	FEB	MEAN 0150 MAR	CHARGE, CFS APR	MAY	JUN	JUL	AUG	SEP
1 2 3 4 5	*********	201211111 111111111 111111111 1111111111	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	14.818 14.176 13.186 11.286 11.014	1.857 1.852 1.846 1.841 1.336	1.6988 2 1.6938 1.6878 1.6828 1.6778	1.544 1.539 1.534 1.528 1.523	1.3853 1.3802 1.3753 1.3678 1.3648	1.195 0.959 0.929 0.929 0.929
6 7 8 9	********** ********* ********* ********	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	14.050 10.037 9.070 7.773 6.760	1.831 1.826 1.821 1.316 1.811	1.672\$ 1.667\$ 1.662\$ 1.657\$ 1.652\$	1.518 1.513 1.508 1.503 1.498	1.359 <b>*</b> 1.354 <b>*</b> 1.349 <b>*</b> 1.344 <b>*</b> 1.339 <b>*</b>	0.955 0.942 0.828 0.714 0.663
11 12 13 14 15		0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	6.669 6.376 5.572 5.138 5.009	1.805 1.800 1.795 1.790 1.785	1.646\$ 1.641\$ 1.636\$ 1.631\$ 1.526\$	1,492* 1,487* 1,482* 1,477* 1,472*	1.333: 1.328: 1.323: 1.318: 1.313:	0.651 0.599 0.572 0.595 0.579
16 17 18 19 20		0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	4.657 4.410 3.917 3.623 3.750	1.780 1.775 1.770 1.764 1.759	1.621# 1.616# 1.610# 1.605# 1.600#	1.467\$ 1.452\$ 1.457\$ 1.451\$ 1.446\$	1.308 1.303 1.298 1.292 1.287	0.549 0.499 0.422 0.391 0.448
21 22 23 24 25		0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	4.607 3.361 2.883 2.658 2.523	1.7548 1.7498 1.7443 1.7398 1.734\$	1.595 1.590 1.585 1.580 1.575	1.4418 1.4368 1.4318 1.4268 1.4218	1.282 1.122 1.031 1.015 0.984	0.478 ********* ********* ********
26 27 28 29 30 31		0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000 0.000	0.000 2.282 1.879 7.951 16.109 13.896	2.672 2.773 2.424 2.358 1 2.056 0.000	1.728# 1.723# 1.718# 1.713# 1.708# 1.703#	1.569\$ 1.554\$ 1.559\$ 1.554\$ 1.554\$ 0.000	1.416# 1.410# 1.405# 1.400# 1.395# 1.390#	0.969 0.969 0.955 0.926 1.040 1.824	********* ******** ******** ********
HEAN HAX HIR	0.000	********* 0.000 0.000 ********	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	42.117 1.359 16.109 0.000 83.539	189.624 6.321 14.818 2.056 376.114	55.173 1.780 1.857 1.703 109.434	48.699 1.623 1.698 1.549 96.594	45.472 1.467 1.544 1.390 90.193	38.840 1.253 1.824 0.926 77.037	::::::::: ::::::::::::::::::::::::::::

Weir capacity exceeded
 Weir washout, no record from 5-2 through 8-20
 Interpolated value

OCT NOV DEC JAN

CF018. APR MAY LI-24



	TION CFO28:		SAND COULEE TO DET 1 198				C 15 MACA		LAI O U	0 N 1.4		. u
w////	12/11/1/10/	7.11	10 000 1 1/0	•	,,,		CHARGE, CES		rui v v	, it follows		, ,
TAY	CCT	NOV	nec	JAN	LLB	MAK	A°R	nAf	JUN	الد	AL T	٦٢
-215 45	*********			0.025# 0.022# 0.018# 0.014# 0.011#	0.000; 0.000; 0.000; 0.000	0.000 0.000 0.000 0.000	0.000:	**********	111111111 1111111111 1111111111 1111111	1111111111		######################################
67 87 10		1:1:::::::::::::::::::::::::::::::::::	0.119% 0.116% 0.112% 0.108% 0.105%	0.007\$ 0.004\$ 0.000 0.000\$ 0.000\$	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.005 0.012	0.0003	13131333 11111131333 11111333333	121111111111111111111111111111111111111	;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;	311111111	
11 12 13 14 15	::::::::::::::::::::::::::::::::::::::	::::::::::::::::::::::::::::::::::::::	0.1013 0.0988 0.0942 0.0908 0.0873		0.000 0.000 0.000 10.130 23.0521	0.000 0.000 0.000 0.000 0.000	15.995 1 8.793 2 1.770	*********	***************************************	::::::::::::::::::::::::::::::::::::::		***********
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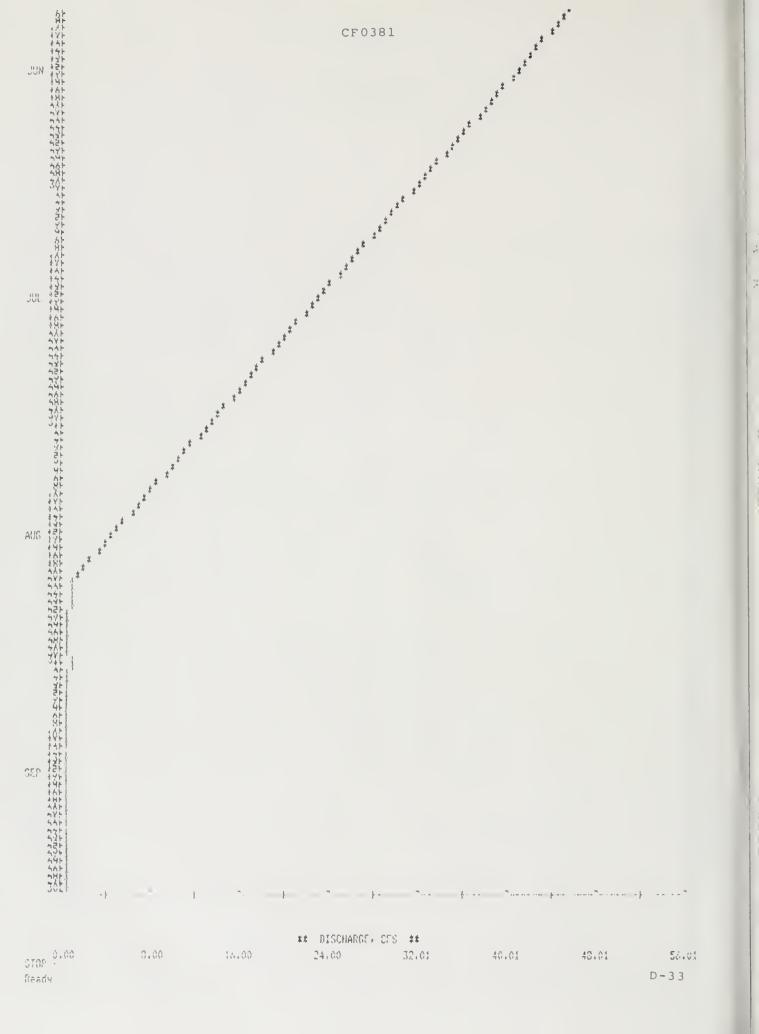
¹⁾ Weir capacity exceeded; washout occured 5-21, repaired 8-21.

^{*} Interpolated value.

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Interpolated value.

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#### APPENDIX E

### PROPOSED AMD MITIGATION ALTERNATIVES

The MBMG proposed 5 alternative acid mine drainage treatment measures for field testing to the Montana Department of State Lands in March, 1983. A description of the theory and proposed tests of each alternative are contained in this appendix.

### E.1 State-of-the-Art in AMD Control

Lime and limestone treatment of acid mine drainage is a proven mitigation technique (Kim, et al., 1982; Bituminous Coal Research Institute, 1971; Hydrometrics, 1982). While lime (Ca(OH)₂) is more effective at neutralization per unit weight than limestone, several factors favor usage of limestone in crushed or pulverized form, including low cost per unit neutralization, local availability, fewer safety problems in handling a less reactive reagent, lower potential for harmful effects on the body of water receiving the effluent and denser sludge. Diebold (1975) found that one-inch crushed limestone fragments provided effective neutralization of iron and copper loads in Montana acid mine drainage at Hughesville, but not of manganese, zinc and cadmium. Even if centralized neutralization facilities are effective, they require significant capital and maintenance investments and are not easily adaptable to treatment of a number of polluting mines over a wide area without a sophisticated collection system, such as is the case at Sand Coulee. In addition, such facilities must be operated continuously, under a variety of discharge and climatic conditions.

Centralized lime neutralization facilities produce large quantities of amorphous sludge which present major handling and disposal problems. Large neutralization facilities are operated successfully, however, in areas where active mining is ongoing, and trained personnel and equipment are available. The lack of mining operations and dispersed nature of AMD sources in the Sand Coulee area are a major impediment to centralized neutralization.

Hydrometrics (1982) list 22 effluent treatment techniques for AMD control at Sand Coulee. They rule out all but three for various reasons: streamflow regulation, evaporation ponds and neutralization facilities. They list 17 mine manipulation techniques, three of which were designated as being potentially applicable: dam and flooding, hydraulic seals and seals using mine backfill. Eight hydrologic system control methods were listed, two of which were deemed potentially applicable: overburden water removal by wells and vegetative evapotranspiration.

Hydrometrics gave a qualitative rating of the potentially applicable methods to 10 acid discharges in the Stockett-Sand Coulee area. The highest rating of any technique was "fair", given to dam and flooding of the ASO4 adit (Brown Mine). Most ratings of success were poor, undetermined, no potential or variable. Overburden water removal methods were rated as poor for all sources, due to inadequate information on the aquifers involved and potentially large costs associated with well installation, maintenance, water pumping and piping. Evapotranspirational controls were rated poor or variable for various AMD sources, primarily due to insufficient information on recharge areas and no previous documentation of this technique for AMD control.

The U.S. Bureau of Mines (Kim, et al., 1982) has recently assessed the long-term success of various acid mine drainage treatments. Their recent inspections of wet, dry and hydraulic and/or bulkhead seals constructed over 10 years ago in West Virginia, revealed failures of 5 clay seals and continued discharge of acid water to a receiving stream. They indicated that mine sealing and flooding of 43,000 acres of old coal mines in Pennsylvania which are below the local drainage elevation, began over 30 years ago and that the water in some mine pools is now slightly alkaline. However, they state that in deep mines above the drainage elevation, "flooding is generally ineffective owing to seepage through fractures and the tendency of the water to migrate to other discharge points." The latter situation is the predominate case in the Stockett-Sand Coulee coal field.

The U.S. Bureau of Mines study briefly mentioned that overburden dewatering methods in the eastern U.S. have had limited success but are highly dependent on favorable hydrogeologic conditions. They made no reference to evapotranspirational control methods as a means of reducing infiltration to mines.

Results of this investigation generally support the findings of the previous studies. Mine sealing is one control technique which has been attempted in the Stockett vicinity. In one case, near the Giffen mine, sealing was performed successfully, but within a few months after sealing, a small seep had developed in the center of a nearby tract of agricultural land. Within a year, the seep had developed into a large marshy area discharging a flow reportedly not greatly different than that of the original spring. Because of the unpredictability of the effects of such sealing efforts, a number of local residents are

opposed to its use, as indicated by the results of the resident questionnaire carried out by Hydrometrics (1982).

# E.2 Infiltration Control by Intensive Cropping Methods

Planting of water-consumptive crops such as alfalfa, sanfoin and safflower and the use of continuous cropping rotations has been shown to be effective in limiting the amount of infiltration allowed to recharge shallow saline-seep ground-water systems (Miller et al., 1981). It is conceivable that application of such cropping practices could reduce infiltration to mine adits that cause acid discharge. Saline-seep research has demonstrated that alfalfa sends roots to depths of 15 feet or more, utilizing 18 in. of water annually, whereas cereal grains root to only several feet and utilize 7 to 8 in. of water annually. Recropping of cereal grains when soil moisture permits will almost double the evapotranspirational water use over the former 2-year crop-fallow system (Brown and Miller, 1978).

A drawback with this approach is that some of the recharge to ground water occurs in the late winter (during snowmelt) or during spring rains, when most crops are not consuming large amounts of water and when direct evaporation is minimal. The soils on the benches are thin and permeable, so that soil moisture may not be retained long enough for it to be consumed by crops in the summer months. However, in this area intensive cropping will decrease the volume of excess infiltration to some extent, even if it does not eliminate it entirely. Other infiltration control methods, such as draining of leaky upland stock ponds or ephemeral natural potholes, may reduce infiltration substantially and should be considered.

Efforts to reduce infiltration by intensifying agriculture, would have to be monitored via observation wells in the Kootenai aquifer and measurement of AMD discharge for a number of years after implementation, before the degree of their success could be evaluated. Full root development and water use by alfalfa, for example, does not occur until the third year after planting.

Acid discharge sources fed primarily by local recharge areas currently in a crop-fallow rotation are the best candidates for testing this infiltration control method. Such areas include the cultivated benches above ASO1, ASO2, ASO6, ASO7, CSO1 and CSO2.

Effective implementation of cropping system charges for control of dryland saline seep has been shown to require technical assistance to the farmers involved (Dodge et al., in press). Long term adoption of intensive farming practices in the study area must prove to be practical and economical if wholesale reliance on subsidies is to be avoided.

## E.3 Horizontal Wells and Connector Wells

Installation and pumping of standard vertical wells to dewater the Kootenai aquifer, which is contributing leakage to abandoned mines, is a potential mitigation measure. However, the continued costs of pumping and maintenance appear to make this an undesirable and expensive alternative.

It is possible to take advantage of, or create, favorable differences in hydraulic head within wells, to gravity drain water from one aquifer to another or to the surface. The two well designs possible for use in dewatering the Kootenai aquifer are the connector

well and the horizontal well. The connector well would drain ground water from the basal Kootenai sandstone aquifer to the Madison group limestone which has a lower head, thereby preventing that water from draining into old mines and becoming acidized. The horizontal well would be drilled from a coulee into the basal Kootenai sandstone, just upgradient from old mine workings, and allow ground water to drain to the coulee before it leaks into the mines.

Connector wells have been used to dewater shallow aquifers in mining applications. A recent U.S. Geological Survey publication (Bush, 1983) describes the successful test of one connector well to recharge 50 gpm under gravity flow from a shallow sand aquifer to the underlying Floridan Limestone aquifer in central Florida. There is limited evidence to suggest that some domestic wells in the Stockett-Sand Coulee area may act as connector wells. A drillers log on a private well in T. 19 N., R. 4 E., sec. 23, indicates that ground water was encountered in the basal Kootenai sandstone, but that drilling continued 356 feet into the Madison limestone where a cavity was encountered. The total well depth was 586 feet, 71 feet below the cavity level and the well was uncased below 20 feet. The reported static water level was 515 feet below ground surface, just at the level at the bottom of the cavity. Ground water from the Kootenai aquifer may flow down the well bore to the level of the cavity in the Madison. The instances of contaminated Madison wells mentioned in section 2.2.5.1 also illustrates the connector well principle. If applied to the AMD problem, the connector wells would inject fresh Kootenai water into the Madison group limestone.

Horizontal drainage wells have been most frequently used in

dewatering of mining headwalls and highway road cuts. In the Stockett-Sand Coulee area, horizontal wells could be drilled into the sides of coulees upgradient from existing AMD sources as a test of this technique. Their obvious advantage is the use of gravity drainage and the elimination of long-term pumpage requirements. Secondarily, the water removed through drainage would be typical alkaline Kootenai water and with a minimum of conveyance would be available for dilution of other AMD water in the receiving stream.

Favorable sites for horizontal well tests include several acid springs and mine discharges near Sand Coulee such as ASO1, ASO4, ASO9, CSO1 and CSO2. The configurations of these coulees and predominantly local recharge sources create apparently favorable conditions for intercepting a sizeable portion of the ground-water flow field reaching the old mine workings.

The drilling distances would be variable, depending on the test site chosen and the quantities of water intercepted as the drilling progresses. It is estimated that a 500-1000 ft. hole would be attempted initially. The yield of a horizontal drainage well in the basal Kootenai sandstone is problematical, very much dependent on the quantity of saturated fractures encountered.

Vertical test wells would be drilled on the benches above these adits to the Morrison coal bed along the projected axis of the horizontal well. This will help confirm the extent of the old mine workings and provide elevation control on the basal Kootenai sandstone prior to drilling the horizontal wells.

The effectiveness of the horizontal wells in AMD control would be determined by measuring the discharge from the two adits with flumes or

weirs fitted with continuous recorders, both before and after operation of the drainage wells. The drainage well discharge would be measured continuously with recording flowmeters or flumes. Both adit and drainage well disharge would be sampled for water quality analyses during the flow tests.

# E.4 Subsurface Injection of AMD

A potential AMD disposal and neutralization method may be gravity injection into the Madison limestone. The effectiveness and impacts of injection could be assessed with controlled field tests. The objectives of the tests would be to determine the effectiveness of AMD neutralization, porosity--permeability changes due to injection, extent of metal precipitation, and water quality impacts of AMD injection on the Madison aquifer.

Acid mine drainage leakage into the Madison aquifer is already occurring throughout the Stockett-Sand Coulee area in an uncontrolled fashion. There are several cases of Madison ground-water contamination reported by landowners and at least four additional suspected cases based on MBMG water quality data. AMD disharge in Sand Coulee, Number Five Coulee, Cottonwood Creek and Straight Creek is known to be lost to subsurface seepage, contaminating alluvial ground waters and probably the Madison as well. The results of controlled AMD injection tests would indicate whether such a procedure is preferable to uncontrolled leakage to several aquifers along the entire drainage network.

However, there is reason to question the applicability of such an injection program. As acid mine water is discharged into partially saturated zones of cavernous porosity in the Madison, several processes

will take place concurrently. If undiluted acid water comes in direct contact with limestone in the unsaturated portion of the Madison, it will tend to dissolve carbonates and may enhance porosity. As the pH rises above 4.5, both iron and aluminum will rapidly precipitate from solution as insoluble, amorphous hydroxides. As it reaches the saturated portion of the Madison, it may have little or no remaining acidity; what acidity remains will be buffered by the alkalinity of the Madison water, causing complete precipitation of the metal load down to the solubility of controlling metal hydroxide or carbonate species.

The major obstacle to the successful operation of such an injection well system would probably be the ability of the aquifer and well to resist becoming clogged with metal hydroxide precipitation products. Mines in the Sand Coulee area, those of poorest quality in the region, typically range from 600-1600 mg/L total dissolved metals, primarily iron and aluminum with much lesser quantities (<50 mg/L Zn, <10 mg/L Ni, Cu, Mo) of other metals. Assuming an average annual discharge of 40 gpm (2.5 liters per second (1/s)) for a hypothetical spring of typical water quality and metal load (TDS = 5000 mg/L; metals = 1.1 grams/L), and assuming a mean density of 3.0 g/cc for the metal precipitate (gibbsite - 2.4; ferric hydroxide - 3.3-4.3, depending on hydration), a total volume of 1024 ft³/year will precipitate from solution in the subsurface if the total discharge were to be injected into the Madison. Assuming a void ratio of 100 percent in this precipitate, approximately 1766 ft 3/year would precipitate from injection water of just one spring. Such volumes could potentially clog even a large zone of cavernous porosity in the Madison over the period of a few years.

However, there are some factors which would support the feasibil-

ity of injection. First of all, the water would most likely be injected into the upper Madison which is partially unsaturated, and before it reaches the water table it may dissolve a significant volume of carbonates due to the water's high acidity, enhancing porosity and permeability. Secondly, our results indicate that acid streamflow is probably currently leaking into the underlying Madison in the Sand Coulee-Stockett area. Therefore, the injection concept may prove practical, provided that zones of cavernous porosity are present in the Madison to accommodate the anticipated metal load.

Certainly, however, the water quality impacts of such injection would have to be predicted and evaluated. Acid water injected into the aquifer would become neutralized with respect to metals and acidity. The Madison aquifer may, however, be degraded by the higher sulfate levels (2000-8000 mg/L) in the acid water, or by an increase in  ${\rm Ca}^{2+}$  and  ${\rm Mg}^{2+}$  concentrations due to carbonate and dolomite dissolution.

Many Stockett-Sand Coulee residents have abandoned alluvial wells for deeper Madison aquifer wells. Any acid water injection proposal would have to be sanctioned by residents and carefully monitored to determine overall impacts. We have proposed one possible approach to conducting controlled field tests and evaluation of the injection technique.

Initial well drilling, logging and testing would be conducted to locate a favorable site. The vertical gradient must be downward, and there should be some initial solution or cavernous permeability in the upper unsaturated Madison group limestone.

An initial 10-day injection test would be run. Following a favorable evaluation of the first test, a second 100-day test would be

conducted. Water quality analyses of the observation wells, injection well and mine discharge would be made three or more times throughout the tests. Field pH, S.C. and alkalinity measurements would be made frequently. Continuous water level data would be collected throughout the test periods. The nearest private Madison well would be sampled before and after the test periods.

Following the tests, geophysical logs would be run again on the injection well and observation well changes in porosity and permeability caused by metal hydroxide deposition and carbonate dissolution. Aquifer pumping tests or slug tests would be re-run to determine permeability changes. Two new wells would be drilled to determine the extent of metal deposition and obtain samples.

The results of field sampling would be used as input to hydrochemical modeling of the injection test. Analytical calculations and computer modeling would be employed to estimate the mechanisms and rate of acid neutralization and metal precipitation over time. The extent of porosity, permeability and water quality effects on the Madison aquifer would be evaluated. Recommendations regarding the long-term hydrogeologic feasibility and impacts of AMD injection to the Madison Group rocks would be made.

# E.5 Flyash Neutralization

Flyash residue from coal-fired electric power plants is rich in calcium and has been tested and found to be effective in neutralizing pyrite induced acidity. Sonderegger and Donovan (1982) conducted acid titration and batch leach laboratory experiments with various mixtures of flyash and pyrite mine tailings and found that flyash has both

short-term and long-term buffering capacity. A one to ten, flyash to tailings mixture, was estimated to maintain a buffering capacity exceeding 100 years. Iron mobility in column leach tests with flyash was reduced by up to three orders of magnitude.

It is believed that small volumes of acid mine drainage water could be effectively neutralized by short-term retention and mixing with flyash in a small pit. An investigation would be needed to test the effectiveness and maintenance requirements of small flyash pits as a means to neutralize the numerous small acid water discharges in the Stockett-Sand Coulee area.

Pits of about 200 ft³ in size would be excavated and filled with flyash. Acid inflows would be injected through the bottom of pits, where neutralization occurs prior to being discharged from the top of the downstream side of the pit. Water quality sampling and field testing of pH, S.C. and alkalinity of inflows and outflows would be done to document the rate of neutralization, bulk neturalization capacity of the flyash in the pit and affects on overall water chemistry and metals concentrations. The pit would be profiled afterwards, and maintenance and operation feasibility assessed.

#### E.6 Kootenai Water Neutralization

A simple and possibly effective AMD neutralization technique would be to mix alkaline ground water from the Kootenai aquifer with small volumes of acid mine drainage water. The mixing would occur in a pit where metals would be allowed to precipitate prior to discharge of the effluent.

Typical ground water from the lower Kootenai formation has an

alkalinity of 200 to 350 mg/l as  $CaCO_3$ . Assuming a mix of 2500 mg/l (as  $CaCO_3$ ) acid mine water, a 10:1 volumetric ratio of Kootenai to AMD water is required theoretically to achieve neutralization.

A several month test would be conducted to evaluate the effectiveness and field procedures associated with utilization of Kootenai ground water in neutralizing acid mine drainage in the Sand Coulee area.

Water quality samples and field pH, S.C. and alkalinity data would be collected at inflows and outflows to document the effectiveness of the technique.

The flyash and Kootenai ground-water neutralization experiments would be conducted with the purpose of determining the minimal field installation required for non-mechanical but effective treatment of the numerous small and ephemeral acid seeps in the study area. Such an alternative could be adopted by individual residents at low cost to assist regional AMD clean up efforts.

## E.7 Treatments in Combination

There will probably never be a single mitigation technique feasible for controlling all acid mine drainages. Once implementation and testing of the previously discussed techniques on an individual basis is completed, various combinations may enhance AMD control.

If the head and permeability characteristics of the basal Kootenai sandstone aquifer prove conducive for horizontal wells, this technique could be combined with mine flooding and bulkheading. The two treatments could complement each other. The horizontal well will provide a hydraulic pressure release mechanism, maintaining hydrodynamic equilib-

rium and helping prevent unplanned seepage. The flooding will slow acid producing reactions in the old mines and may increase head in the overlying sandstone, thereby improving yields from the horizontal well at the expense of mine flow. The discharge of alkaline ground water from a horizontal well may provide an opportunity to neutralize the remaining acid flow in a pit below the source as indicated in the previous section.

Reductions in acid mine baseflows and total volume from intensive farming methods in recharge areas may allow installation of retention ponds or neturalization pits (using flyash or limestone) to treat the remaining acid flow. Mine flooding and bulkheading could be combined with injection of surplus water to a deeper receiving zone such as the Madison group limestone. A closed system overflow pipe could siphon surplus mine pool water in a relatively unoxygenated state to a deeper receiving aquifer. If acid-forming reactions could be minimized in the mine and rapid injection of ground-water recharge slugs accomplished, the injection water may be of better quality than typical AMD water. Mine pool water injected in this manner may result in water quality impacts to the Madison aquifer less than those currently being experienced.



